56th NORTHEAST REGIONAL STOCK ASSESSMENT REVIEW COMMITTEE (SARC-56)

Center for Independent Experts (CIE) independent peer review report on the 2013 Atlantic Surfclam and White Hake Benchmark Stock Assessments

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Prepared for

Center for Independent Experts

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Executive Summary

The Process

The SARC review process was well supported by all involved. The Center for Independent Experts (CIE) was efficient in providing the formal documentation and supporting logistical arrangements. NMFS/NEFSC staff ensured that progress was made under sometimes difficult circumstances and all participants in the meeting were hospitable and helpful. This facilitated progress and made the meeting enjoyable as well as interesting and challenging.

Technical documentation was provided before the meeting, although severe weather delayed the white hake report until one week before the commencement of the SARC 56 meeting. The volume of technical information made available is substantial, the two assessment reports running to nearly 800 pages, with a further 25 documents provided as background. Reading and effectively assimilating this amount of information in the short time available to prepare for the review is extremely challenging. Clear and concise reporting is therefore essential.

Both reports and presentations tended to move to the final assessment without providing a detailed consideration of exploratory runs and model development. This seems likely to be a response to the limited time available for the review, as there simply would not be enough time to completely rerun assessments following suggestions for improvements by the reviewers. Limited time during the meeting also puts substantial pressure on the assessment scientists with regards to generating new outputs for presentation when requested. In general, requests for additional information were substantially met, but with occasional exceptions. Determination reference points for white hake resulted in delays in this meeting, because the SAW report did not contain sufficient information and when requested, definitive outputs could not be produced in time for the meeting. As a result, the meeting finished with reviewers having to reach a consensus on the basis of preliminary results, eventually confirmed during the following week. A knock-on effect was that projections could not be completed during the review meeting. Working across very different time zones after the meeting complicates and delays effective communication between reviewers.

In summary, the volume of material to be considered and the short amount of time available increase pressure on all concerned and may reduce the quality of the process. However, overall the process permits thorough independent review of US NMFS stock assessments within a short time frame.

Atlantic surfclam

The SAW carried out a thorough assessment of the Atlantic surfclam fishery in accordance with the specified ToRs, all of which were addressed and largely fulfilled. The assessment has been improved through significant new work to better estimate survey dredge efficiency and selectivity as well as to implement a new assessment model in a new software framework (SS3) that permits utilisation of catch at age data. The already substantial experimental and modelling work to estimate the efficiency of the survey gear was extended by new work to model the depletion experiments. This resulted in improved information on the variability of survey dredge efficiency, which is higher than previously estimated. Although this represents an improvement to the assessment process, unfortunately the higher survey efficiency variance results in more uncertainty in the level of biomass estimated. The new stock assessment methodology permitted the use of survey age data for the first time. Inclusion of these additional data should provide more information on the stock structure and therefore improve fitting as well as providing better and more explicit estimates of recruitment. As would be expected, there were some issues with using a new software package, and despite extensive efforts the SAW was unable to implement a 'single stock' model accommodating 2 spatial units with very different exploitation characteristics. The SAW's approach of implementing a separate model for each area and combining outputs to provide 'whole stock' summaries was flexible and fully appropriate, enabling both single and two stock scenarios to be considered. Under the existing single stock definition and it indicates that the stock is not overfished and that overfishing is not occurring. The SAW was unable to reach consensus as to whether single or two stock definitions were more appropriate and passed this decision to the SARC Panel. The SARC Panel felt that insufficient evidence was provided for them to make a decision at this time and that 'local' scientists and managers with better knowledge of the biology and management of surfclams would be better placed to make the decision. The current model specification is flexible and permits assessment under either scenario, while current (and likely near term future) stock status does not indicate an imminent need to make this decision. The SARC panel considered that the assessment outputs provided a credible basis for management, but felt that they could have been improved by better presentation and explanation of model diagnostics in relation to choice of model parameters and settings and that sensitivity to a wider range of states of nature (e.g. M) could have been undertaken for both the assessment and projections. The use of simple methods (e.g. catch curves, comparison of unexploited and exploited population structures) to provide supporting evidence for the low level of exploitation and the level of natural mortality provides additional confidence in the assessment outputs.

White hake

The SAW carried out a range of evaluations in order to address the ToRs specified for white hake, thoroughly addressing most, although the projections specified under ToR were not completed. The Review Panel decided not to accept a recommendation by the SAW to alter the F_{MSY} proxy reference point from $F_{40\%}$ to $F_{35\%}$. There were considerable revisions to catch data including incorporating some of additional data and using nominal white hake landings rather than splitting based on survey proportions to ensure consistency with the red hake assessment. These should result in an improved time series of landings data. The SAW also carried out a though investigation of survey and commercial catch rate data, although only two survey series and no commercial LPUE data were included in the assessment model. The SAW also completed a thorough evaluation of the impact of using pooled ALKs on the white hake stock assessment, which indicated that they were useful where annual ALKs were unavailable. A new assessment model was used and the SAW provided a thorough account of the transition between assessments, noting that the stock trends were generally robust to a range of models that had been used over the last 3-4 assessments. Uncertainty in the data for white hake is considerable, with some concerns regarding the stock definition, the species being taken primarily as a by-catch in mixed fisheries, heads-only landings contributing to uncertainty in length data and species identification and difficulty in ageing from otoliths increasing uncertainty in catch at age data. The SAW carried out simulation work to support proposed new reference points, but did not present full results and there was some uncertainty over estimates presented verbally during the meeting. The Review Panel did not accept the change in reference points, taking account of a rapid increase in risk level associated with the change from $F_{40\%}$ to $F_{35\%}$, particularly as the steepness parameter of stock recruitment relationships was reduced. The SAW had not fully documented short term projections and the change in reference point definitions added to the delay. These remain to be completed after the meeting. The SARC panel considered that the assessment outputs provided a credible basis for management, despite the data uncertainties, but felt that they could have been improved by better presentation and explanation of model diagnostics in relation to choice of model parameters and settings and data selection choices. They also felt that sensitivity to a wider range of states of nature (e.g. M) could have been explored for the assessment and that this should be followed through to projections when carried out. The very limited time available for review means that once problems are encountered there is very little opportunity for revisions and completion of the process.

1. Background

This report provides an independent review of benchmark assessments of Atlantic surfclam and Gulf of Maine and Georges Bank white hake carried out at the Stock Assessment Workshops (SAW-56) and presented at the 56th Northeast Regional Stock Assessment Review Committee (SARC-56) meeting. The Review Committee was provided with internet access to stock assessment reports and background material prior to the meeting. Prior to participating in the 56th Northeast Regional Stock Assessment Review Committee meeting from 19th Feb. – 22nd Feb 2013, documentation provided was read to familiarise myself with background and identify potential issues. The review panel was chaired by Dr. E. Houde and all reviewers contributed with regards to both assessments.

There was generally a high level of agreement between CIE reviewers, so although this report is my personal review of the both stock assessments considered at SARC 56, it has much in common with the SARC summary report. I have endeavoured to capture briefly most of the issues raised during the meeting and comments made in the SARC summary report (such that this report can stand alone), but focus further on the aspects I personally felt most important or on which I was best able to contribute. The CIE statement of work, requires that additional documentation including: a Bibliography of review materials (Appendix 1), a copy of the CIE Statement of Work (Appendix 2) and the Panel membership (Appendix 3) are provided as appendices.

The Panel suggested that I take a greater role in the surfclam assessment and this is to some extent reflected in this report, which has a greater emphasis on surfclam.

2. Review activities

The Review Committee convened at the Laboratory of the Northeast Fisheries Science Center (NEFSC) in Woods Hole, Massachusetts, from 19th Feb. – 22rd Feb 2013. The Committee comprised a chair and three panel members. Plenary sessions were open to the public at the meeting and via Webex and conference call.

Tuesday 19/02/13: Presentations of the Stock Assessment Workshop (SAW) results for Atlantic surfclam was given by assessors from the working group (Daniel Hennen & Larry Jacobson). This was followed a plenary discussion of the material presented and an opportunity for the Review Panel to comment and request further material. The Panel requested further information on bridge building between assessments, assessment diagnostics and an alternative assessment assuming lower natural mortality.

Wednesday 20/02/13: The SAW white hake assessment lead scientist (Katherine Sosebee), assisted by the WG chair (Gary Shepherd), presented data and results for the white hake assessment during the morning sessions. The first session of the afternoon provided an opportunity for public participation and for the Review Panel to comment on what had been presented. The Panel requested more diagnostics from the base run including MCMC outputs to check for convergence, a summary table of model parameters for key stages in the development of the base run and suggested using recent (slightly lower) recruitment as an alternative state of nature for projections.

This was followed by a return to surfclam, with follow up presentations from Daniel Hennen & Larry Jacobson clarifying points raised by the Panel the previous day and discussion to decide upon alternative states of nature to be explored through projections.

Thursday 21/02/13: Katherine Sosebee made follow up presentations on white hake and the Panel commented that although the analysis was thorough, more explicit inclusion in the SAW report of diagnostics and decision making steps with regards to model selection would be useful. They also requested more explanation on the risk levels for the alternative FMSY proxy reference points, which were not presented in the SAW report. The previously requested MCMC outputs were provided and the Panel noted that although possibly not fully converged initially, later in the time series they were fully converged. The Panel requested these be added to the SAW report as an appendix. The SARC then proceeded to commence editing the Assessment Summary Report. However, at this stage the lead assessment scientist expressed some concern regarding reference point values used by the SAW during the alternative reference points risk analysis. Under the worst case stock recruitment scenario (steepness of 0.7) the risk was higher than previously thought. The Panel concluded that using SAW rationale for adopting the higher yielding FMSY proxy (F35%) no longer justified moving away from the default F40%. However, before making a firm decision this analysis needed to be rerun to confirm that the outputs being considered were the correct ones. This also had knock-on effects for other subsequent and dependent sections of the SAW report and Assessment Summary Report that could require reruns of projections. Staff of the NEFSC therefore proposed to rework this and dependent sections of the assessment and report to the SARC committee (and SAW group) during the following week. The short report providing the definitive results of the reference point simulations was provided by email (arriving Thursday 27th Feb, UK time).

A final plenary session was extended into the evening to permit completion of editing of the SARC Assessment Summary Report. The public meeting was then closed.

Friday 22/02/13: The Review Panel met in closed session and discussed the SAW ToRs for both stock assessments, while making a preliminary draft of key points and conclusions for the independent SARC review panel report which indicates, whether or not: i) each ToR was completed successfully and ii) whether the work presented provides a scientifically credible basis for developing fishery management advice. In reaching consensus, reviewers considered data adequacy and usage, the appropriateness and implementation of analyses and models applied and the interpretation and conclusions drawn.

The SARC chair and Panel members subsequently prepared and exchanged drafts of the various sections of the SARC report by email, with the chair coordinating and editing the final version. Individual reviewers prepared their independent reports following the meeting. There were few disagreements between the panel members regarding most issues, and therefore my independent review should largely reflect the SARC review report developed at and following the meeting, but with focus on the issues I personally considered in more depth.

The SARC group also reviewed aspects of the assessment summary reports for each stock during plenary sessions, but because of revisions to the white hake reference points and delays in projections, the report for that species was not finalised.

3. Review findings – Stock assessment reviews

<u>3a. Atlantic surfclam in the US EEZ</u>

> ToR 1. Estimate catch from all sources including landings and discards. Describe the spatial and temporal patterns in landings, discards, fishing effort and LPUE. Characterize the uncertainty in these sources of data.

<u>The SAW met this ToR.</u>

The management of the surfclam fishery is relatively rigorous, requiring compulsory completion of logbooks and the landing of clams in tagged cages. Fishing and processing operations are heavily capitalised and automated and the general quality of landings statistics is considered high. Further the fishery is single species and the automated nature of operations ensures fishers avoid areas where other species might occur which would require manual sorting and reduce operational efficiency. The industry targets clams of large size and high meat yield and the rate of discarding has fallen to around zero since minimum size regulations were removed in the early 1990s. Catch is estimated by adding a constant 12% to landings (and discards), this being considered an upper bound, because incidental mortality is considered low based on the very small area fished relative to the area of the stock distribution. The landings tagging system and lack of discarding mean that, in comparison with many fisheries, landings and catches are well defined and recorded in the surfclam fishery.

Discarding is reported to have fallen to zero and is not discussed in detail in this section of the report. However, detailed information on the cooperative survey programme methodology indicates that clams are mechanically sorted onboard dredgers using a shaker table with rolling bars to grade out smaller clams. In this case the SAW is considering the onboard grading operation as part of the gear selectivity hence considering discarding zero. Under other definitions this could be considered automated discarding. This process deserves mention under the ToR considering discarding along with statements to indicate the potential damage/mortality/ survival levels of the clams returned to the seabed in this manner. Information on the potential volume of this catch component would also be useful.

The assumption that incidental mortality is a constant proportion of catch follows from assuming that the landings provide a representation of the number of clams contacted by the gear and that the structure of the catch is equivalent to the landings. This may hold for weight and volume terms, but size selectivity means that many more small clams will be contacted than are retained. Therefore there is the potential for higher incidental mortality in small clams that are not yet fully recruited and contributing to the fishery. An alternative assumption would be that incidental mortality is related to area swept. However this does not take account of the heterogeneous distribution of surfclams, whereas the proportion of landings does. Nonetheless, as effort has more than doubled since 1991, it may be that incidental mortality has increased and especially for smaller clams. Although the fishery operates only on a small fraction of the overall resource, these are likely to be the higher (clam) density areas, subject to economic and operational range, and given that there are some concerns regarding post-settlement development and recruitment of surfclams, the impact of incidental mortality could potentially merit further investigation.

Landings are measured volumetrically in bushels conversion factors are applied to convert to meat weight which is the unit used in the assessment. The panel expressed some concern over both the consistency of the bushel as a unit and the potential for variability and bias in the meat weight conversion factor. Clam condition is likely to vary seasonally with reproductive status, as well as temporally and spatially in response to environmental drivers (especially temperature). The Panel recommended that further work be carried out to improve conversion factors for surfclams. This was also a recommendation of the previous SARC reviewers.

The SAW report presented numerous tables and figures summarising landings, catch, effort LPUE and nominal and time adjusted revenues and their trends in both space and time. A variety of spatial scales were used, including whole stock, northern and southern (sub-) areas, regions and important ten minute squares (TMS). Details are also provided for state waters which are not included in the EEZ assessment (although this might be more sensible biologically) and recreational fisheries were noted as near zero and for bait only. These tables and figures provide a comprehensive description of the commercial data (and their trends) available for this fishery. A minor inconsistency is that Table A4 notes that prior to 1981 effort data were less reliable due to restrictions on hours fished per day, while the SAW report text (p.9) indicates that effort data were not reliable for 1985-1990 (for the same reason) and considers them reliable before and after this time period.

Trends in landings, effort and LPUE for ‘important’ ten minute squares were very useful both in highlighting some pervasive general trends as well finer scale variability in exploitation history at this scale. Despite the valid *a priori* conclusion that commercial LPUE may not provide a reliable biomass index in a fishery which targets localised high density areas of a more widely distributed and spatially structured stock, the key features of the analytical assessment are apparent in many of the important TMS LPUE plots, i.e. increase in the eighties, followed by a plateau for some and decline for others, and decline in recent years. The plots were more difficult to interpret spatially, because of the relatively large number of squares considered, which although grouped regionally did not provide a feel (to an outsider) for their spatial location and relationships between them. Providing these plots in a spatial format (even if schematic/stylised) would be interesting, but potentially also a significant amount of extra work. The technique of fitting a smoother to the time series was very effective in preserving the information signal, whilst protecting personal data.

The SAW report suggests that commercial data are generally accurate and points out some exceptions (e.g. effort), thereby giving a general description of potential uncertainty, but there are no direct efforts to quantify uncertainty in these data.

Neither ToR 1 nor ToR 2 explicitly specifies consideration of commercial length data. I briefly consider it here.

Metadata for commercial length sampling were tabulated and resultant length distributions plotted by year and region in the SAW report. They indicate a relatively low individual sample size (*circa* 30 clams per sample), which is as recommended in the port sample instructions. The number of trips sampled generally reflects the importance of the area, with New Jersey the highest, followed by Southern New England (in 2011) and Long Island in recent years, whilst Delmarva has declined from high levels to more moderate levels with poor sampling in some years. In general, the numbers of trips sampled appear reasonable to obtain spatial and temporal coverage, assuming Georges Bank (GBK) is increased as more fishing takes place in this area. The numbers of clams per sample appears rather low, as although the fishery targets large clams (with a relatively narrow size range), the range plotted (Figures A14-A18) covers around 12 size classes (c. 7-18cm), assuming 1cm size classes. Low individual sample size is likely to result in noisy length distributions and if sampling strays from random may bias contrast in either direction. <u>Increasing sampling sizes by around 50% (or towards 50 clams per sample) could be beneficial in improving precision, particularly now that length data are fitted in the assessment model.</u> It will also be important to ensuring adequate spatio-temporal sampling coverage is maintained, especially as the fishery shifts its distribution and landing and processing locations. <u>No details on the process for aggregating length distributions to annual and area or region based strata was provided in the SAW report.</u>

As a minor point (re. figures A14-A18 and other TS of plots in the report) presenting palettes of sequential plots of length or age structure vertically (rather than horizontally) greatly improves clarity and increases opportunity to follow features through time.

The SAW report seems to indicate that sampling occurs at ports, and during the meeting a comment from the floor noted that processors may be located away from the landing site. Information provided at the SARC Panel's request suggests that ageing is precise and straightforward in comparison to some other species. It could be worth investigating the potential of a cooperative programme with processors to sample commercially sampled clams for age and length at the processing site. Such a scheme could offer advantages of high sample numbers for both age and length at potentially a few sites, with minimal operational disruption and cost, assuming that both age and length can be derived from shells after extraction of the clam meats and as long as the provenance of the sampled landings are maintained and can be ascertained at this stage of processing. The major overhead of such a scheme seems likely to be sample preparation and reading for age.

> ToR 2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, relevant cooperative research, etc.). Investigate the utility of commercial LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data.

The SAW met this term of reference in presenting survey data and characterising their uncertainty and by considering the utility of commercial LPUE data, although the utility of the latter was not explicitly investigated.

The SAW report provides an extensive account of the survey data and analyses associated with them, while additional background material (e.g. Rago *et al.*, 2006; Hennen *et al.*, 2012) covers some more technical aspects of the analysis to estimate dredge efficiency, a key part of this assessment. The effort put into monitoring survey dredge performance and technical consideration of the survey efficiency and selectivity involves both scientists and Industry and is highly commendable as well as adding to the assessment credibility.

More generally the survey data were well presented in the SAW report, with numerous tables and figures detailing: metadata; abundance and biomass indices with measures of dispersion; survey length and age data; data, diagnostics and results relating to dredge performance efficiency and selectivity; shell length to meat weight relationships; as well as results of fitting growth curves by year and region and analysing trends in growth parameters.

The sheer volume of information in this section makes it difficult to structure in the SAW report and indeed to critique herein. Key aspects considered most important include:

a) Survey coverage - Historically surveys have tended to take place at around 3 year intervals and coverage has not always been complete primarily due to bad weather. This situation is generally worse for the GBK area due to its greater isolation and exposure. The previous SARC review recommended moving to a model based approach to deriving data for missing strata, but this proved unsuccessful in this assessment and the SAW reverted to the previous method of interpolating data from the neighbouring surveys in time. Despite this set-back further attempts should be made to develop model based filling algorithms for missing data.

   The temporal approach to filling data will smooth abundance/biomass indices over the missing time period whilst maintaining the spatial integrity of the data, which is likely to be important for stock which is sedentary and likely to show high spatial variation in density and where the data will be used as in index or for swept area biomass estimation. Abundance changes moving through the chosen population subsections (<120mm & >=120mm) over time are likely to occur at a similar or slower rate that the frequency of surveys and will still be effectively tracked.

   It was not clear in the SAW report how the survey size and age distribution data were aggregated over sampling strata and regions and if any (and if so what) measures were put in place when coverage was poor. For instance in the South Virginia (SVA) region the surveys in 2005 and 2011 had no spatial overlap (strata in common) with the 2008 survey, but length distributions were presented in the report in all these years. There was no discussion of the potential effects of poor coverage on the assessment diagnostics or outputs. Any spatially driven differences in length and age compositions would be interpreted in a temporal dimension in the analytical assessment. Future SAW reports would benefit from a clear description of data aggregation protocols for size and age data used for modelling.

b) Survey dredge efficiency and selectivity – Many resources are devoted to this topic in terms of a cooperative survey programme with Industry to provide depletion based estimates of survey dredge efficiency, research to develop better method of analysing the data, monitoring of the survey dredge performance and further modelling and presentation of the results in the SAW report. These are all important aspects in parameterising and understanding the assessment model.

Survey dredge efficiency is a key parameter in scaling the biomass estimated by the model. New methodology was developed and applied to analyse the depletion data and estimate survey dredge efficiency. This improved the estimation of uncertainty in the dredge efficiency, which was unfortunately was considerably higher than previously thought and thus increased uncertainty in the scaling of biomass estimates from the assessment as well as externally derived swept area estimates. Nonetheless the new methodology represents an important step forward.

Four new depletion experiments were carried out for this assessment, with 3 yielding satisfactory results and the fourth producing 'unreasonable' results. Table A11 indicates that it did not converge and produced an efficiency matrix of 1. The SAW noted that this experiment suffered from a very low catch on the 13th depletion tow and that altering this value towards the expected catch produced results very similar to the other 3 experiments. The SAW also noted that logs of physical parameters for the tow did not provide any *a priori* reason to exclude it. However, the ultimate usage of the results of this experiment was not explicit from the SAW report, presumably un-used (p.16). Diagnostics presented for the four depletion experiments indicate that the SC11-04 run had a lower overall variation in residuals than the other runs and the highlighted problematic point does not show any signs of fitting poorly in comparison with other points in that experiment. However, the diagnostic plot of residuals by tow may show a systematic positive to negative trend, driven primarily by the first and penultimate tows/points. There may be a more general tendency for the first few points to have positive residuals and the last to have negative residuals.

The report notes that survey dredge efficiency has been difficult to estimate and is likely to vary in response to local environmental conditions, in particular substrate properties, wind and currents and outlines (repeat tow) experiments carried out to provide additional estimates of survey dredge efficiency. These were used together with results from the depletion experiments to provide a basis (59 points each with CV) for an inverse CV weighted bootstrap derived histogram to which a lognormal distribution was fitted as a prior distribution for survey efficiency for input to the assessment model. The SAW noted that estimates of efficiency greater than 1 were excluded (Run SC11-04 is absent from this dataset, so excluded, see comment above). The raw and fitted distributions of efficiency estimates show that the majority are very low, but a few are very much higher (i.e. lognormal distribution). Although the SAW report notes the likely impact of environmental conditions on survey dredge efficiency, no data are presented on these in the SAW report and no analysis to investigate (or adjust for) the impacts of environment to survey efficiency are reported. The outputs in figures A40 and A53 both suggest that there is a strong variation in efficiency between stations and <u>some analysis of this in respect to recorded environmental parameters for the tow (e.g. wind force, current velocity and direction relative to tow, wave height, substrate classification if known) could be useful in better understanding and/or adjusting for variation in survey dredge efficiency</u>. It is planned that commercial sized dredges will be used for future surveys. These are considerably more efficient and their larger size may reduce variability in efficiency due to weather conditions. Nonetheless, environmental conditions are still likely to affect dredge efficiency and taking this into account (if possible) could improve precision. Although future surveys may be less susceptible to environmentally induced variation in survey dredge efficiency, retrospectively adjusting historic survey data (if possible) could still improve the assessment.

The improved modelling approach for selectivity was useful in demonstrating the pervasive nature of a domed selectivity pattern for the survey dredge, in providing prior information for assessment and in highlighting variation in efficiency between stations.

c) Variation in growth – At the Panel's request documentation indicating the reliability of surfclam ageing was made available at the meeting. Age and length samples from the survey were available from most regions in most surveys and time series of von Bertalanffy growth curves were fitted by region. Data were generally fairly plentiful for the Delmarva and New Jersey regions with the exception of the 2011 survey, while they are scarce for all years in the other regions.

The SAW notes these growth curves are generally consistent within region except in New Jersey and Delmarva. In these regions (inverse CV) weighted regressions of growth parameters against time indicated declines in L_∞ and K and L_∞, respectively. One explanation considered was that these changes may be in response to adverse changes in the environment in the more southerly regions, potentially resulting from climate change. Inspection of the regression of growth parameters (Figs. A64-A66) suggests a step change rather than a linear relationship with the first 6 years appearing as distinct groups in Delmarva and New Jersey, while the second 8 years and most recent year are distinct groups in Delmarva, but less so for New Jersey and for K in particular. Within the first group there is a strong upward trend in L_∞ on a shorter time scale (with corresponding downwards trend in K in NJ; von Bertalanffy parameters are usually negatively correlated), while the second group show little trend, but possibly still slightly upward.

Both the step function and shorter time scale trends could warrant further investigation, particularly as they move in opposite directions. Hence on a short time scale it appears that L_∞ was increasing in the early part of the series (K for New Jersey decreasing so overall growth may be more neutral), but then around 1990 there was a sudden decrease in L_∞ in both areas which was maintained subsequently. This is not particularly consistent with the theory of climate change where a more gradual and consistent change might be expected. A major population die off of surfclams (and possibly their predators) occurred in 1976, which was followed by a very strong year class. These clams would be approaching the plateau of the growth curve around 1989-1990 and it could be that the change in estimated growth parameters reflects the particular dynamics of this year class (e.g. density dependent stunting) and the relative scarcity of older year classes from 1989 onwards. It is noticeable that there are more points at older ages on the asymptotic part of the von Bertalanffy curves for these two regions up to 1986 and a scarcity of points at older ages in all curves subsequently, particularly in Delmarva. The 2011 survey appears poorly sampled for growth data in both regions. The true level of L_∞ may therefore be less well estimated in surveys since 1989. Some caution should be applied to rationalising trends and step changes in growth parameters as relating to climate change and careful consideration given to the growth parameters used by the assessment model. The SAW chose to use a single growth curve in the assessment model and suggested the early growth data could be anomalous. The latter is not supported by the greater amount of data apparent in the early growth plots, but the decision to use a single growth curve seems sensible at the current time.

d) Shell length - meat weight relationships - An improved generalised linear mixed modelling approach was used to estimate new shell length to meat weight relationships. Incorporation of random effects terms for station is helpful in overcoming correlations between samples from the same site, which are otherwise incorrectly assumed independent. The remaining predictive variables are length and depth (both on log scale) and region and year. The approach also permitted more appropriate consideration of the error structure on the transformed scale, hence the true variability is better modelled and estimated. There are regional and depth variations in this relationship and to produce a standardised curve for the whole stock the average depth of all survey stations (33m) was used.

e) Utilisation of commercial LPUE - The SAW concluded *a priori* that commercial LPUE was not an adequate measure of relative abundance because the stock is sessile and the fishery targets a few areas of relatively high density within economically viable ranges of ports. This is a valid conclusion; however commercial LPUE data from important TMS show a high degree of similarity to the overall stock trends estimated in the analytical assessment. In order to complete a more formal investigation in the future, the SAW could include commercial LPUE in alternative assessment runs to explore their impact on the assessment, or include them as non-fitted 'ghost' data as was done with some variables in this assessment. Application of some form of generalised linear modelling to standardisation for spatial and/or vessel effects prior to inclusion in the assessment model would be useful.

ToR 3. Evaluate the current **stock** definition in terms of spatial patterns in biological characteristics, population dynamics, fishery patterns, the new cooperative survey, utility of biological reference points, etc. If appropriate, recommend one or more alternative stock definitions, based on technical grounds. Integrate these results into TOR-4.

The SAW addressed this ToR fairly comprehensively, presenting tables of alternative views on stock definition in relation to each aspect mentioned in the ToR, as well as providing results from larval drift modelling, but they could not reach consensus on stock definition. Being unable to reach a consensus on stock definition the SAW passed the decision to the review panel. However, in my view, insufficient evidence was presented in the SAW report to make a well informed decision at this time. Further research is likely to be required to provide conclusive evidence in this regard. Redefining the stock may also have restrictive implications for management and external reviewers are less well placed to make this decision than local scientists and managers who have a more detailed and in depth knowledge of both the stock biology and potential management issues.

Nonetheless, the issue of stock structure was rightly raised at SARC 49 that the assessment indicated the current good stock status could be maintained purely by the un-fished GBK stock component, potentially leaving southern regions open to overfishing. However, this issue could be addressed through spatial management measures, rather than necessarily requiring a redefinition of the stock. The Panel was in agreement that no redefinition of the stock was required at this time, but some aspects of the discussion and issues may warrant further elaboration here. These can be considered under two headings:

a) Biological issues - Both SAW and SARC meetings included discussion on variations in biological parameters, genetics and recruitment dynamics.

   There are clear spatial variations in biological parameters (e.g. growth, condition factor), but these would be expected for any sedentary species, potentially both in response to micro-environment as well as wider environmental gradients. It would therefore be expected clinal variations in biological parameters would occur over the spatial distribution of the surfclam stock most probably in relation to latitude and depth. That such variations do occur does not provide a rationale for stock separation.

   Genetics was also discussed with reference to no genetic differences being found among samples of surfclams from the while spatial range, being indicative of a single stock. The counter argument that this does not prove population homogeneity was also expressed in the SAW report.

   It was pointed out that year class strengths apparent from the survey age data appeared to be different in different parts of the stock, but it was inconclusive as to whether these were indicative of regional variations within a single stock or 2 or more separate stocks. Studies on other species have suggested that larvae tend to be retained on Georges Bank while published larval drift models for scallops show drift from Georges Bank to the south, but none in the opposite direction. The prevailing currents in the area are from north to south. Preliminary results of larval drift models for surfclam presented in the SAW report (Table A19) indicated no exchange of larvae between Georges Bank and other areas (in either direction), but some exchange (in both directions, but primarily southward) between contiguous regions further south. A scaling error in this table (relating to multiple releases of larvae) made interpretation more difficult, but did not obscure the overall picture. It was pointed out that this study was preliminary and did not include any mortality of larvae, but also that under some conditions up to 10% of larvae from Georges Bank could move to southern New England and although not considered viable in the model they would be near a reasonable size for metamorphosis.

It therefore appears that Georges Bank is relatively isolated from the other regions, although larval dispersal to the south could occur under certain circumstances. Larval dispersal in the opposite direction seems more unlikely and GBK may therefore be considered primarily as self sustaining and a potential (limited) source of recruitment to the other regions. There is likely to be more exchange of larvae between regions within the southern area.

b) Suitability of the stock assessment model - The current assessment was implemented as two separate stock components which were combined to provide output metrics for the stock as a whole. Although a stock recruitment relationship is implemented in the models it has a fixed high steepness so recruitment is effectively modelled as variations around a mean level. Although SS3 should permit a single model with two separate areas the SAW could not implement this model successfully. The two separate models approach is sufficiently flexible to provide outputs from both single and 2 stock hypotheses and provides a suitable basis for management under either of these scenarios. If a common stock recruitment relationship were thought to apply over the whole stock area and this was effectively implemented as part of the assessment fitting process, then a single stock model would be required. However, current knowledge of the recruitment dynamics is not sufficiently well known to support this hypothesis and limited data for the northern (GBK) area may not be sufficient to contribute substantially to such a model fit.

The current two separate model approach without strong stock recruitment assumptions provides a pragmatic and flexible solution, which should be able to accommodate management needs. Therefore there is no imperative to redefine the stock unit at this time but further work to clarify recruitment dynamics would be useful.

ToR 4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-3), and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results. Review the performance of historical projections with respect to stock size, recruitment, catch and fishing mortality.

<u>The SAW met this ToR</u>, although they did not explicitly calculate either total or spawning stock biomass, rather estimating a measure of 'summary' biomass, broadly comparable with that estimated in previous assessments using a different model (KLAMZ). There were some aspects of the assessment that could have been better presented, explained and investigated further. The SAW provided a number of relatively simple alternative calculations (e.g. catch curve estimates of Z, comparison of surveyed population structure with un-fished projected population and swept

area biomass estimates) that supported the parameters used for and estimated in the assessment (i.e. natural and fishing mortality and biomass) and are highly valued in this respect.

The use of a new modelling framework (SS3) permitted the use of survey age data and provides annual age structured estimates of stock numbers, rather than aggregated biomass estimates provided by previous assessment model. The new model permits more data to be used and provides outputs that provide more explicit information of year class strength. The model fits a stock recruitment relationship during estimation, but the steepness parameter for this was fixed at a high value (0.95), therefore recruitment was essentially fitted as deviations from a mean level. The previous model used a random walk to constrain successive recruitment estimates and the new model should be an improvement on this.

SS3 should permit multiple areas to be considered within the same model, but the SAW were unable to implement such a model successfully, despite a significant investment of time. They therefore opted to implement two separate models, one for the northern (GBK) area and another for the southern areas (SNE, LI, NJ, DMV, SVA). This flexible approach permitted them to consider both single and two stock definitions (see ToR 3) as well as accommodating the different exploitation histories and lengths of data series of the two areas. The approach also allows for alternative biological and fishery parameters to be used or fitted in the different areas. Key differences between the two areas implemented in these assessments included a domed selection pattern for the south and an asymptotic selection pattern in the north; the rationale being that in the south fewer very large clams were available due to some depletion on the main as fishing grounds, this not being the case in the new fishery in the north. Summary biomass was estimated as biomass of clams for ages 6+ in the south and 7+ in the north due to differences in growth rates, this output metric being approximately equivalent to the biomass estimates provided by the previous assessment model implemented in KLAMZ. The SAW noted that many parameters for the northern area had to be 'borrowed' from the south because there was insufficient data to fit them in the north.

The SAW provided documentation relating to previous and updated KLAMZ models in appendices providing a bridge to the current assessment and presented a historical retrospective in the SAW report. The new SS3 assessment has rescaled biomass compared with the previous assessment. Rescaling between assessments is a feature of this stock assessment where the absolute level of biomass is determined by primarily by survey dredge efficiencies which are low and variable. The biomass trend was broadly similar to previous assessments, in that it is domed and declined steadily from a peak to the present time. However, the new assessment differed in that biomass peaked around the late 1980s, whereas in all previous KLAMZ assessments it peaked around the late 1990s. This is considered further in respect of model fit and reference points.

The SAW report included 5 tables (A20-A24) detailing the structure and sub-models, data used and parameters fitted for the SS3 models for each sub area. Limited diagnostics were presented in the report for the southern area only. Graphical diagnostics produced by the r4ss package in R were presented for each area in separate appendices, but these are poorly labelled and without explanation. Many diagnostics were also presented during the meeting. The volume of information and speed of presentation made thorough interpretation of these difficult. All reviewers agreed that clear text and decision tables presenting (and explaining) key diagnostics highlighting the investigation and subsequent choice of alternative models during the model development phase would be beneficial.

Discussion of the model fits in the SAW report and SARC meeting concentrated on the southern area where more data are available, and the northern area is also covered very briefly herein. The SAW report noted that the most important issue for GBK was sparse data, which limited estimation of key parameters and added to uncertainty.

Age and length compositions for the northern area generally fitted more poorly, because (both fishery and survey) data are more scarce and sometimes poorly sampled and the model borrowed some parameters that were fitted for the south. Nonetheless the fitted age distributions captured many of the features in the observations. Length data generally fitted less well for both the limited commercial data and survey distributions. Survey length data fitted more poorly to the early surveys (1984, 1986, 1989) and could not fully capture a high peak in 2008. There is some correspondence between these years and the early years (1984, 1989) when survey sampling was disrupted on GBK (Table A8), but more recently sampling success and goodness of fit do not correspond well.

Trends in output metrics for GBK show F corresponding to historical and recent fishing at low levels (<0.01)), while biomass was relatively stable through the 1980s and 1990s, rose to a peak in the early 2000s before subsequently declining. Recruitment (age 0) appeared stable until the early 1990s, then peaked in the mid 1990s before dropping to low levels from 2000 onwards.

The SAW report noted 4 key issues regarding fitting of SS3 preliminary runs in the southern area: growth parameters, fit to 14+ sizes in the commercial data, lack of fit to early survey data (overall trends and size compositions) and lack of fit to the largest sized clams in the commercial data.

The SAW considered variation in growth rates in the south (see ToR 2) was probably due to anomalous survey size data in the earliest years (1982-84 & 1986) which remained unexplained. They therefore decided to keep growth parameters constant over time. This decision would also be consistent with my discussion in ToR 2. A series of runs were carried out to investigate fitting to different combinations of the 5 growth parameters in SS3. The 2 best fitting models gave implausible results and were excluded, with the SAW settling for the third best fitting model which estimated the two parameters *Lmin* and *Lmax* only. This curve had the lowest *Lmax* and highest *K* (fixed at this level for many runs) of the parameters presented in the SAW report.

Using a dome shaped selectivity pattern for the commercial fishery (in the south) addressed problems in fitting to larger sizes and was justified with the rationale that continuous fishing had reduced the abundance of larger clams in these areas. Domed selection for the survey is justified on the grounds that the smaller dredge and lower pump pressure do not capture large clams, which may be more deeply buried, effectively. Both justifications are plausible.

The SAW report noted that the survey fit was sensitive to weighting and that increasing its weight resulted in an improved survey fit, but poorer fit to all length and age data. The SAW concluded that the survey trend data were noisy and poorly fitted because there was no evidence in the length and age data to support the survey trend. The panel were interested in this aspect of the assessment and asked for further diagnostics.

The survey data are noisy in the in the early 1980s, low around 1990, have a peak in the late 1990s then decline to lower levels more recently. There is some concern that the peak may be (to an unknown extent) an artefact caused by higher than normal pump pressures during the 1994 survey and possibly this problem also carried forward to the 1997 survey, although this is not certain. Not surprisingly when the survey data were given a higher weight the trend in biomass more closely followed the survey trends and was more similar to the previous KLAMZ results, with a peak in biomass occurring in the late 1990s. Inclusion of the age and length data and no additional weighting of the survey abundance index results in the peak of biomass being shifted to around the late 1980s.

The assessment scientist noted that the model generally fitted the commercial length data and survey length and age data well for the southern area, but had concerns about the early 1980s when they fitted less well. The survey data are also noisy at this time. However, the Panel noted that residual patterns and plots of fitted length and age compositions indicated that poor fits also occur at other times. Fishery length data show small clams present in the length data in the early 1990s that are not well fitted (1994 in particular), the 1999 length distribution looks poorly sampled consisting predominantly of large clams and fits poorly, while peaks in the length distributions around the early to mid 2000s are not particularly well modelled. The survey lengths show the same features of smaller clams in the mid to late 1990s which are not well fitted. Residual plots confirm these points with high residuals apparent around 10cm lengths in the commercial fishery during the late 1990s and similar residual patters around 3-5cm and 12-13cm in the survey around this time. The survey age data generally fit well although a peak around ages 4-5 in 1992 is not well captured. These data are consistent between fishery and survey suggesting there may have been high recruitment to the fishery in the early 1990s and also that high recruitment to the stock may have occurred at smaller sizes around this time. They are also all generally consistent with an increase in biomass occurring in the late 1990s, something the current model does not capture. <u>More detailed consideration of the age, length and survey trend data through the 1990s may be required to improve future assessments as this period shows features in all the data sets, but is also subject to some quality concerns.</u>

Survey efficiency estimated in the assessment was around 0.33, increased substantially above the mean of the lognormal prior (0.24), but still plausible. This parameter scales the biomass output by the model and alternative values were used to provide projections under different states of nature (see ToR 6).

The SARC panel felt that the SAW could have investigated alternative states of nature more fully and asked for an additional run exploring a lower natural mortality. This was brought forward and showed that the survey efficiency parameter was estimated to be very high (>1) and this resulted in a rescaling of biomass to much lower levels, but with similar trends. Biomass status was similar to the base run, because both the reference level B1999 and current biomass were rescaled. However, fishing mortality was much higher, and at the FMSY proxy (F=M) of 0.15. Unfortunately there was insufficient opportunity to examine this run more closely, to check its internal consistency or to use it as a basis for projection. It was pointed out that the previous SARC had explored alternative levels for natural mortality. A number of simple calculations were carried out to lend support to the both assessment results and assumed level of natural mortality. These included:

a) Comparison of an estimated unexploited population structure and the observed population structure – the similarity suggests that exploitation is low.
b) Catch curves based on the survey data from GBK to provide estimates of total fishing mortality where exploitation is very low hence Z approximates M – static catch curves (calculated from single year length distributions) rather than year class curves provided a range of values with mean and median close to 0.1. However, there was wide variation, with 1986, 1992 and 1999 surveys tending to give higher estimates of mortality (0.14-0.19), while 1989 and 2002 gave values around 0.1 and 2008 and 2011 gave very low values. Low recruitment in recent years was postulated as the reason for the low recent values and excluding these resulted in a mean of 0.13. These results gave support for the general level of M=0.15, but did not preclude the potential for it to be lower.
c) The observation that old clams, *circa* 30 years of age, are still fairly common in survey catches provides support general support for low levels of total mortality.

Whilst these results suggested that the overall level of mortality on the stock is low, they did not preclude the possibility that M is lower and this is a topic that should be explored in future.

Stock and fishery trends for the south indicated biomass rising in the 1980s and declining since then. Recruitment increased in the late 1970s and early 1980s and has since declined to lower levels, potentially increasing slightly again in the last 10 years. Fishing mortality is low overall (<0.05), but was highest in the 1970s and early 1980s, decreased through the 1990s and has risen since 2000.

Separate area assessments were combined to provide whole stock results consisting of summed biomasses and fishing mortality estimated by summing catch numbers for both regions and dividing this by the sum of average fully selected abundances in both areas.

Current catch is within the range explored by previous assessments. The current biomass estimates were outside the 95% confidence interval of the previous assessment, but this reflects a change in scaling with new data and methodology available to estimate survey dredge efficiency. Internal retrospective runs showed the little bias, but a tendency for biomass to rescale as successive surveys dropped out of the assessment. Fishing mortality was not explicitly commented on in the SAW report with respect to the historical retrospective and the numbers based method of estimating F in the current assessment differs from the KLAMZ approach.

Both combined and separate area assessments were considered to provide plausible and relatively robust descriptions of stock trends, providing a useful basis for management. The combined assessment for the whole stock indicates F is low and increasing slightly to approximately 0.03 in 2011, while biomass has declined fairly steadily over the last two decades in response to low levels of recruitment.

ToR 5. State the existing **stock status** definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. This should be carried out using the existing stock definition and, if possible, for the recommended "alternative" stock definitions from TOR-3. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the appropriateness of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

The SAW met this ToR.

The SAW report stated the existing definitions of reference points, which are both proxies. $F_{MSYproxy} = M = 0.15$ which is the overfishing limit (OFL) and $B_{MSYproxy} = 0.5^* B_{1999}$. The overfished threshold for biomass is defined as $0.5^*B_{MSYproxy}$. The exact rationale for choosing B_{1999} as a proxy was not entirely clear but it was considered to broadly represent a relatively un-fished state, i.e. carrying capacity. It was noted that using biomass in a reference year, rather than an absolute value overcame problems relating to the rescaling of biomass in successive assessments. The SAW updated the estimate of $B_{MSYproxy}$ with relevant biomass estimate from the new SS3 assessment. The SAW did not consider it necessary to re-evaluate this reference point, despite the fact that the trend in the time series of biomass estimates has changed since the last assessment. Previously, B_{1999} was just below the maximum biomass in the time series, whereas in the new assessment it is relatively much lower. Moving to a new and improved assessment framework has required substantial investment of effort during this assessment iteration. Once this assessment is fully embedded and assuming the current trends persist, a re-evaluation of reference points may be beneficial.

ToR 6. Evaluate stock status with respect to the existing assessment model and with respect to any new assessment model. Determine stock status based on the existing stock definition and, if appropriate and if time permits, for "alternative" stock definitions from TOR-3.

The SAW addressed this ToR with regards to the new assessment model, but did not explicitly comment on status as estimated by an updated run of the old model.

a. When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.

The SAW updated the KLAMZ model with new data in an appendix, but did not report the status with respect to reference points based on that assessment.

b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).

The new SS3 model was used to provide estimates of stock status under both potential stock definitions.

The two area modelling approach used with SS3 is flexible enough to accommodate defining reference points under both single and two stock assumptions, and given the existing reference point definitions, although estimation of biomass for the northern area is problematic due to scarcity of data in this area. At the present time only an experimental fishery has been operating in the northern area, and the SAW noted that by definition this stock must be near un-exploited levels and cannot be overfished. Estimated F is this area is far below the OFL. Estimated biomasses and fishing mortalities in the southern area and for the combined whole stock assessment indicated that in both these cases the stock was not overfished and overfishing was not occurring.

Estimated confidence intervals from the assessments indicated that the probabilities of overfishing or being overfished were minimal for the whole stock definition. However, for the southern area the SAW reported a possibility that the stock was overfished as there was overlap of the summary biomass and biomass threshold 95% confidence intervals.

> ToR 7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).

The SAW fulfilled this objective, using the SS3 model as the basis for projections. The SAW report did not contain information on stochastic projections, but these were brought forward at the SARC meeting. Statistical distributions were calculated for the ABC corresponding to the OFL, but not for the OFL and ABCs (under for catch based scenarios) as these are pre-defined without variability.

> a. Provide numerical annual projections (3-5 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).

Estimated uncertainties in the basecase SS3 model were used to provide stochastic projections exploring the probability of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Terminal year estimates of abundance were used to provide recruitment estimates for the duration of the short term projections, so no additional assumptions about future recruitment were required. Probabilities were estimated as the probability of not achieving the required thresholds in any year and there was some discussion as to whether this was the most appropriate measure. There was also some discussion as to whether probabilities were over-estimated due to correlations between instances of threshold and projected biomass from the same stochastic iteration.

> b. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.

The SAW did not consider multiple states of nature initially, but some projections and alternative model runs were provided at the SARC Panel's request, including alternative biomass scales based on different survey dredge efficiencies. No projections with alternative M were possible because of time limitations and inconsistencies with the alternative M assessment (see ToR 4).

The *status quo* catch scenario was considered the most likely of the projections presented by the SAW, because recent landings have been consistently under quota and the fishery is limited by market constraints and operational economics. Projections under this scenario indicated low probabilities of the stock being over-fished in the short term. Projections for GBK have higher uncertainty because the assessment is less certain and future landings were a 'best' estimate provided by the Industry based on likely fishery development.

> c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

The SAW did not explicitly report on this sub-ToR, but the SARC panel considered the stock's productivity and susceptibility to overfishing, noting that there are some concerns that productivity could be lower than currently assumed, however susceptibility to overfishing is low because the fishery operates only over a fraction of the area occupied by the stock.

> ToR 8. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in the most recent SARC reviewed assessment and review panel reports. Identify new research recommendations.

The SAW met this ToR, summarising progress against previous research recommendations and providing seven new ones (including one carried over). The SARC report contains brief comments on each.

A number of the recommendations relate specifically to the stock assessment, including topics on SS3 modelling, survey design and redefinition of reference points. These could be augmented by some suggestions from this review, such as further investigation of growth data, evaluating the impact of environmental factors on survey efficiency and evaluating the utility of modelling commercial LPUE data and including them in the SS3 assessment model.

Others are more general including topics relating to surfclam habitat, responses to climate change and spatial modelling of the resource and fishery.

3b. White hake

> Tor 1. Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of fishing effort. Characterize the uncertainty in these sources of data. Analyze and correct for any species mis-identification in these data. Comment on the consistency of the approach to identify the catch of white hake with respect to that used in the red hake assessment.

The SAW addressed this ToR thoroughly, presenting data on landings and discards from a range of fleets and over a considerable time period.

The SAW provided extensive data on landings of white hake, extending back to the late 1800s. In the early part of the time series landings were around double the highest levels seen in the last 50 or so years, the time period used for the assessment model. The SAW report notes that landings have been recompiled and include additional state collected data, not captured in the NEFSC database until later years.

White hake are landed 'heads off' which introduces uncertainty in reported weights and length sampling as well as exacerbating the potential problem of misidentification with the red hake, which is similar in appearance to white hake, particularly for smaller individuals. Revisions to white hake landings used for this assessment included more consistent application of landed to live weight conversion factors. Previous assessments have recommended using the ratio of red to white hake in the survey to allocate catches between red and white hake constituents. However, low numbers of samples for red hake in the north and white hake in the south have made this approach in adequate and therefore nominal catches were used for assessment of red hake in SAW 51 (2011) and a consistent approach was used for white hake in this assessment. There is a combined red and white hake market category, which has previously been omitted from landings (and catches) and this was included in this assessment, with a species allocation based on the proportion of the two species by statistical area. The approach used to separate white and red hake catches appeared entirely consistent between this assessment and the red hake assessment.

The US accounts for the majority of landings, with small amounts from Canada, whilst landings from other countries have been negligible since 1977. Recreational landings of white hake have generally been low, but are potentially subject to substantial estimation error and were presented, but not used in this assessment.

In the recent time period used for this assessment, landings rose from low levels (1000-2000t) in the 1960s to peaks in the mid 1980s and 1990s (6000-8000t) before falling to low levels in the late 2000s (1000-2000t) and increasing since then to around 3000t.

Discards were estimated for the three major fleets/gear types (large and mesh otter trawl, shrimp trawl & sink gill net) catching white hake from 1989 onwards and for another two fleets (longline & scallop dredge) from 1992 onwards. Discards previous to these years were hindcast back to 1963 using the average (of the first 3 years estimated) of half year discards/landings ratios by fleet. Discard estimates ranged from 36t in 2007 to 1500t in 1993, with CVs from 12-44%. Most discards occur in the otter trawl fisheries (both small and large meshed) and occasionally in scallop dredge fisheries. Occasional very high discard rates were robust to the stratification scheme with the suggestion they were related to strong year classes. Discard mortality for hake is considered to be 100% as they usually have everted stomachs when caught.

The revisions to the catch data in this assessment have resulted in slightly lower catches than those used in the previous GARMIII assessment.

The SAW described the temporal and spatial distribution of fishing effort through a time series of plots indicating landings and effort the major gears in ten minute squares (TMS). They noted that the early data were available only at quarter degree resolution and centring of these on one TMS may have distorted the distribution slightly. The SAW briefly described spatial trends which are also considered in more detail in the background information provided to the Panel, which noted the disappearance of white hake from some inshore areas and postulated this could have resulted due to reduced availability of alewives, an anadromous species that is an important fodder species. Spatial plots were also used to depict the spatio-temporal trends in the distributions of discards for the major fleets.

The SAW also provided time series of nominal effort data which were considered in the section on commercial LPUE. Commercial LPUE was standardised for season, area and vessels size using GLMs, and a standardised effort figure derived by multiplying nominal effort in each model cell by the product of the retransformed model parameters, then summing over all categories to obtain annual totals. Trends in nominal effort (all trips with any white hake) broadly followed landings for the otter trawl fleet, declining from higher levels in the 1980s and 1990s to low levels in the late 1990s and mid 2000s, with a small peak around 2003 and an increase over the last few years. Effort for directed trips (> 40% white hake in landings) followed the trend in directed landings very closely, with the same underlying trend as all trips but with more contrast. Nominal all trips effort for the sink gill net fleet showed a gradual increase to a peak around 2003, a subsequent decline through the mid 2000s and an increase in the most recent years. Directed effort (40%) for gill nets showed a similar pattern to the all trips effort, but with more contrast. Standardised effort for all fleets was noisy but generally at quite high levels prior to 1995. It was low in the late 1990s rising to a small peak in 2003-4, then dropping to low levels in 2006-8 and rising sharply subsequently. There have been days at sea controls in place on the white fish fleet in recent years, which may have contributed to the effort reductions in the late 2000s.

<u>The time series of catches produced by the SAW is credible and uncertainty was described, although not necessarily quantified statistically.</u>

> ToR 2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Investigate the utility of commercial or recreational LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data.

<u>The SAW met this term of reference comprehensively.</u>

The SAW presented data from NEFSC spring and autumn bottom trawl surveys as the primary source of abundance and biomass indices. These surveys have a random stratified design and cover the area under consideration and have been conducted since the 1960s (Autumn 1963, Spring 1968).

Other indices presented included the NEFSC shrimp survey (1985-2012) and state surveys in both spring and autumn from Massachusetts (1978-2012) and Maine-New Hampshire (2000-2012). Neither state survey covers the whole assessment area, but the SAW noted that the Massachusetts survey can still be useful, particularly for young fish. <u>The final assessment model used only the NEFSC spring and autumn bottom trawl surveys although the rationale for excluding the state and shrimp surveys was not provided in the SAW report.</u>

The ship used to carry out the NEFSC bottom trawl surveys was changed in 2009, resulting in many differences in operational procedures. An extensive series (636) of paired tows was carried out to investigate differences between the two vessels performance and provide data to estimate calibration factors where appropriate.

A review group proposed methodology based on a beta-binomial model, but also recommended using a ratio estimator under certain circumstances and not attempting to estimate calibration factors for species that were not well sampled. Since that review it has become apparent that for many species it is also necessary to account for size due to different selectivity characteristics of the vessels and changing size structure in the population.

A range of beta-binomial models were fitted to the calibration data for white hake exploring different assumptions regarding the effects of length and using AIC as an indication of best fit, possibly. These suggested the possibility of an effect at a length of around 7cm, but only 7 fish less than this size were sampled, and only one of these by the new ship, resulting in considerable uncertainty regarding this model. There were insufficient data to estimate seasonal effects, although using site-specific stations and survey stations to split these groups resulted in a small improvement to the AIC criterion. The SAW report notes that survey and site specific data did not support the use of a calibration factor changing with length, logistic models for hose data providing the same fit as the constant model, while a logistic model constrained to have negative slope fitted more poorly and a double logistic model fitted but did not provide variance estimates. The SAW therefore decided to use a constant calibration factor. The Review Panel noted that systematic patterns in length based calibration factors (e.g. preponderance of low estimates at larger size, albeit with overlapping CIs; Fig. B79) did not entirely support this conclusion.

The NEFSC survey suggests abundance and biomass increased between the 1960s and 1990, then declined and was low from 1995 until 2006, after which it has increased. Biomass and abundance indices from the shrimp survey which covers the Gulf of Maine region suggested a decline in the early 1990s, an increase in the late 1990s followed by a relatively stable period since then. The Massachusetts survey suggests that biomass was low in the late 1990s and early to mid 2000s, but has increased recently and the Maine-New Hampshire survey support this trend since 2000. There is reasonable consistency between survey trends with exception of the shrimp survey not capturing the recent increase in abundance.

The SAW provided a time series of spatial plots of data from the NEFSC bottom trawl and two state surveys to illustrate regional trends in survey indices. Length distributions available from all the surveys provide indications of strong recruitment events. Age data are scarcer. The shrimp survey data were not aged and length slicing was applied to the Maine-New Hampshire surveys. Age data were available for the Massachusetts surveys and the NEFSC surveys, but data from the full survey area were required to provide sufficient coverage of all classes and a pooled ALK was used for years where age data were unavailable (<1982 & 2003). The use of pooled ALKs is discussed in ToR 3. The SAW noted that the age compositions do not show many strong or poor year classes, commenting that this may be due to the considerable amount of imputation involved in deriving annual ALKs as well as the difficulty of reading white hake otoliths and resultant reduced quality of ageing.

Commercial LPUE data for US vessels were calculated for otter trawl and sink gillnet fleets. White hake is primarily a by-catch species in the mixed groundfish fishery, so indices including data for all trips that included for white hake as well as more directed trips where white hake accounted for >40%, 60% and 80% of trip landings were investigated. These 'directed' trips generally accounted only for around 15%, 4% and 1%, respectively, of total fleet white hake landings for otter trawls, and 47%, 29% and 5% of sink gillnet white hake landings, so the SAW concluded that they may not be very meaningful as stock indices. The higher percentage directed trips had years with no data so the SAW decided to use the 40% directed criterion along with un-directed trips. The SAW noted a discontinuity in effort data for sink gillnets up to 1993 and from 1994 onwards, that they attributed to a change in reporting procedure at this time. Gillnet effort and LPUE were therefore analysed only from 1994 onwards.

The SAW standardised LPUE by applying a GLM to the LPUE data for all otter trawl trips taking white hake and 40% directed otter trawl trips from 1975 -2011 and for all sink gillnet trips taking white hake from 1994-2011. A four factor model was applied to account for year, quarter, area and vessel size, as well as an alternative formulation including an additional year*area term. All main effects were highly significant. The SAW noted that trends nominal and standardised LPUE series were similar and that standardised effort has declined overall for both fleets, but may have increased recently for directed otter trawling.

LPUE series are quite noisy and trends differ in detail, but they generally decline from the 1970s to the 1990s and show some increases recently. The standardised indices for both gear types show a peak in the early 2000s, with low levels before and after and an increase in the most recent few years. Despite carrying out a generally comprehensive analysis of LPUE data, these data were not used in the assessment and the SAW did not comment explicitly on their utility as a measure of relative abundance.

Spatial distributions of LPUE plotted by TMS showed the otter trawl fishery had highest LPUEs in the northeast of the Gulf of Maine, while sink gillnet LPUE was highest in the southeast Gulf of Maine and there was some indication of an increase in LPUE in 2008-2011 in both series.

Commercial LPUE were not used as indices in the final assessment model, but the CIE reviewers noted that the evaluation of commercial LPUE was thorough.

ToR 3. Evaluate the utility of pooled age-length keys for development of a stock assessment model.

The SAW met this ToR in the specific context of this white hake assessment.

The SAW report notes that the choice of model in the previous GARM III assessment was influenced by concerns that the use of a pooled age length key in the alternative model might dampen estimates of recruitment. This ToR aims to address this issue.

Data from the previous assessment were therefore analysed in the current assessment by re-evaluation using alternative models, a traditional VPA using the ADAPT calibration approach and a forward projecting statistical catch at age model (Age Structured Assessment Program, ASAP). A key difference between the approaches is that ASAP assumes error in the catch at age data while the VPA assumes these data have no error.

Annual age and length data used in this analysis were available from both the commercial fishery (1989-2000) and the surveys (1982-2000). Eight scenarios were considered applying four configurations to each model:

i) Annual ALKs for both commercial and survey data
ii) Annual commercial ALKs and pooled survey ALK
iii) Pooled commercial ALK and annual survey ALKs
iv) Pooled ALK for both commercial and survey data

Retrospective analyses, sequentially removing the most recent year's data from the assessment, were carried out to evaluate the different scenarios. Biological reference points (BRPs) were calculated to assess the impact of pooled ALKs on stock status and YPR analyses were run to determine $F_{40\%}$, the F_{MSY} proxy reference point.

VPA produced results that were similar under all scenarios for recruitment, but differed in terms of F and SSB, with scenarios i and ii differing from scenarios iii and iv. The best fitting model was iii and the worst was ii, but all models detected three strong year classes 1988, 1989 & 1998.

ASAP model runs were more similar to each other, and detected the 1983 year class as well as the three year classes noted above. The best objective function was for the scenario when all ALKs were pooled, but there was little difference between scenarios.

Retrospective biases for SSB and F were large from the VPA runs, while that for R was smaller. Pooling commercial ALKs reduced retrospective bias in F and SSB, while pooling survey ALKs increased it. Retrospective bias in R was slightly reduced by more pooling of the data.

ASAP models showed moderate retrospective bias in SSB and F, which increased as more data were pooled, and high bias in recruitment that increased if the survey ALKs were pooled.

Despite differences in terminal year estimates of SSB and F, stock status determinations were robust for both models under all scenarios.

The results were interpreted as indicating that the white hake assessment was more sensitive to model choice than pooling of ALK data and that relative year class strengths were stable over the VPA and ASAP models. The SAW concluded that for white hake, which does not exhibit high variation in year class strength the use of pooled age data when necessary was reasonable.

This analysis provides a sound evaluation and supports the case for using pooled ALKs in this assessment where annual age data are unavailable. However, the tendency for a large retrospective overestimation bias in recruitment using the ASAP model should be considered with respect to the final assessment.

> ToR 4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results. Review the performance of historical projections with respect to stock size, recruitment, catch and fishing mortality.

The SAW fulfilled this term of reference.

The SAW used a new model ASAP to carry out the assessment in 2012 and carried out a large number of preliminary models to explore alternative model configurations. They implemented two time periods for selectivity, with a split in 1997/1998, to provide comparability with the ASPM/SCAA model used previously, although not other justification was made for this change in selectivity.

The SAW provided narrative supported and graphics to build a bridge from the previous ASPM/SCAA model used in the GARM III assessment through to the current model and data specification. Further detailed information on the ASPM/SCAA model was provided in an appendix. Trends were broadly similar, but the level of SSB was estimated to be lower between around 1970 to 2000, and F was estimated to be higher through the 1980s and 1990s. Recruitment was generally estimated to be lower over the whole time series. The new catch and catch at age data seemed to have the most influence in comparison with changes to the survey indices.

The SAW report specifies the data used in the final model and notes that effective sample sizes (ESS) were initially set on the age compositions according to their quality and subsequently ESS were adjusted according to information on the overall fit between predicted and observed mean age of the catch. However as this resulted in some very low ESS for the spring survey in early and later time periods the SAW decided to use the average of the ESS for both fishery and survey catch at age. The SAW noted that the final base model suggested the ESS should have been higher on early survey age data, but these were not adjusted.

The diagnostics referred to above do suggest that a higher ESS should have been applied to the spring survey in particular which is particularly noisy in the earlier years. There is some possibility that a lower ESS could have been applied to the surveys in more recent years, where the fits seem generally good with the occasional large residual.

The SAW noted that some CVs (particularly at ages 7 & 8) on the starting population (1963) were very high and investigated this further. They noted that ASAP estimated a higher F_{1963} than the previous ASPM/SCAA model and they produced a likelihood profile for a range of fixed F_{1963} values. These runs showed a wide range of F and SSB values over the early part of the assessment time series, which tended to stabilise for SSB after 20 to 30 years although it remained unstable for F for a longer period of time. By contrast recruitment was stable throughout the assessment period. The SAW ran a similar ASAP profile staring in 1989 which resulted in a range of SSB and F values that were consistent with the model started in 1963. However a profile for the ASPM/SCAA suggested a much lower F and higher SSB for the starting year. The SAW concluded that the difference was primarily due to the influence of the survey catch at age data in the early years. They decided that the consequent uncertainty in the level of SSB in the early years, which are influential in estimation of stock recruitment parameters, precluded the use of a SRR for reference point estimation at this time.

Overall, the SAW concluded that the ASAP base model fitted well without strong residual patterns to the commercial or survey catch at age data with the exception of a large 1982 residual for the autumn survey which has always been problematic.

Although this is true, the log scale residuals for the catch show some systematic pattern, being mainly large and positive in the early part of the series, with one large and a preponderance of small negative residuals in the more recent part of the time series. The first (1963) residual is a very large negative value, the influence and impact of which was questioned during SARC meeting. The assessment lead noted that the data working group had recommended using data from 1963 and as this long time series gives some convergence when compared to starting in 1989 the full series was preferred. They agreed that excluding the 1963 point might have been preferable, but its poor fit had only come to light late in the process.

Retrospective analysis showed the model had a tendency to very slightly underestimate F and very slightly overestimate SSB. Recruitment also tended to be over-estimated and sometimes quite substantially. The over-estimation bias in recruitment may be related to 'shrinkage' towards average recruitment for the most recent year(s) in the current situation where recent recruitment is lower than the time series mean. With few data are available to estimate the most recent recruitments they are likely to be more heavily influenced by the stock recruitment relationship which is constrained towards the mean recruitment level.

An historical retrospective was presented graphically in terms of the current status relative to reference points. This showed that despite three different models being used the overall trends in status were very consistent and that the new model was comparable with previous assessments. Differences in scale were primarily driven by the underlying catch data, rather than the choice of assessment model.

The WHWG considered the ASAP base model to the best model with which to evaluate stock status. The SARC Panel agreed that it provided an adequate basis for management.

The SAW report presents point estimates of the 2001 SSB (26,887t), biomass (31,225t) and fishing mortality (0.13), with confidence intervals extracted from posterior distributions estimated by MCMC simulation. In response to a reviewer's request MCMC diagnostics were presented to the meeting to check for convergence. Although not fully converged in the early years the MCMC chains were stable in later years and these were considered more important for estimating CIs of current status and feeding into projections. The Panel agreed that the posterior distributions provided a valid characterisation of uncertainty.

The SAW did not compare the current estimates of stock parameters with historical projections. Projection outputs from the GARM III assessment were included in the background information provided to the SARC and provided outputs for the selected run (A2). At that time the stock was overfished and experiencing overfishing, and the projection outputs discussed related to a rebuilding plan and projected acceptable catch levels for 2009, although *status quo* catch and F_{MSY} based projections were also carried out. From the data provided it is not clear how the current assessment compares with the previous forecast and its probability distribution. However, the current assessment has revised data and used a new model and absolute values of SSB and recruitment have been scaled downwards from previous assessments, while F has been scaled upwards but ids similar in recent years. Current landings of around 2900t are higher than the *status quo* or rebuilding plan values, but the current assessments revised figures were lower (c.1700t) in 2009.

> ToR 5. State the existing **stock status** definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

<u>The SAW fulfilled this ToR</u>, stating the existing reference points, but noting that the assessment model and data have changed and that these reference points were no longer valid. The SAW proposed new proxy reference points based on $F_{35\%}$ rather than $F_{40\%}$, and supported by

simulation studies and the rationale of Clark (1991, 1993) to support changing the choice of the F_{MSY} proxy. They provided a carefully considered case for the change, but did not present detailed output from their simulations and when brought forward at the Panel's request, these were inconsistent with what had been suggested verbally and no longer supported the criteria for change put forward by the SAW. The Panel therefore rejected the new reference points, proposing the slightly more conservative F40% which has generally been considered the default option. This is discussed further below.

The current assessment uses a new model and input data have been significantly revised. Output metrics for the stock are therefore not directly comparable with the previous assessment and the SAW correctly concluded that previous reference points are no longer appropriate.

The SAW noted that ideally reference points should be based on a stock recruitment relationship. SSB estimates from the early part of this assessment are highly uncertain and using only recent SSB and recruitment points would not provide sufficient contrast to adequately fit a representative stock recruitment relationship. An F_{MSY} proxy was therefore required.

The previous assessment had used F40%, which is widely used and based on the rationale of Clark (1991, 1993). The SAW summarised Clark's rationale for F40% as a low probability that the spawning stock would fall below 20% of its deterministic pristine level ($0.2SSB_0$), when projected under a constant F. The SAW decided to investigate this approach specifically for white hake and selected a risk criterion that there should be no more than a 5% probability that the population would fall below $0.2SSB_0$. Demographic parameters from the final ASAP run were used and the SAW considered three alternative stock recruitment relationships which they noted as plausible. These were:

i) random selection of recruitments from the full time series generated by the ASAP model, with recruitment linearly reduced to the origin if SSB fell below the lowest observed
ii) A Beverton and Holt relationship with a steepness parameter of h=0.8, and σ_R of 0.48, estimated from the ASAP outputs from 1982 onward to avoid influence by the pooled ALKs
iii) As for ii except with a steepness of h=0.7

The SAW provided fully selected F values associated with a 5% risk of falling below $0.2SSB_0$ in any one year (once the spawning biomass distribution had stabilized) for each scenario. These were: i) 0.35, ii) 0.25, and iii) 0.22. Proxy reference points presented in the SAW report were based on the ASAP demographic parameters and were F40% = 0.2 and F35% = 0.24.

The SAW concluded that 'Since the risk levels of these two reference points do not differ greatly, the WGWH recommended that F35% (i.e. a fully selected F=0.24) be adopted as the proxy for FMSY as it allows for higher yield'.

However, the SAW report did not present the explicit risks (or the yields) associated with each reference point and stock recruitment relationship permutation. Questions posed by Review Panel drew responses that the risk levels were around 4% for both reference points and that yield gains amounted to a few hundred tonnes.

The Review Panel accepted the approach as a valid method of setting reference points, but requested that the explicit risk levels be provided for each scenario. One reviewer commented that the 5% risk level is precautionary and that 10% is widely used. However, the Panel also felt that the acceptable level of risk should really be set by managers rather than at a technical meeting of scientists and Industry.

The assessment scientist brought forward values for the risk levels, but with some concerns regarding whether they were the values originally considered by the SAW and related to the accepted final run. These indicated a higher risk level for F35% (11%) under scenario iii, which is also apparent from the original SAW report figures since F35%=0.24 exceeds the 5% risk value for F in scenario iii (i.e. 0.22). The (provisional) new figures indicated a significant increase in risk level when changing from F35% to F40% in scenario iii. The Review Panel decided the SAW argument for changing from the default F40% reference point was not well supported (by their own criteria that the risk levels were similar and below 5%) and rejected the new reference points, proposing a return to the $F_{40\%}$ as an F_{MSY} proxy.

Clark's rationale incorporates 'averaging' over models to obtain a 'central tendency' and although under this rationale the 'average' risk level for F35% was reduced and close to 5%, there was still a substantial increase in risk level associated in changing from $F_{40\%}$ and the SAW criteria were fully supported. Although this 'averaging' was implicit in the SAW's consideration of the reference points, a more explicit inclusion of it *a priori*, along with the other assumptions which were made explicit would have been useful. 'Averaging' over different outcomes can reduce transparency and an explicit independent consideration of plausible options generally provides more insights into the behaviours of the variables considered and the causes underlying these behaviours. If an averaging approach is used then care should be taken to carefully justify the choice and range of plausible scenarios considered.

In order to ensure that the correct figures were being considered and used, it was proposed that the assessment scientists check the simulations outside the meeting and report definitive results during the next week. One reviewer also requested an additional stock recruitment parameter be included to provide more information about the shape of the response of the risk surface in relation to stock recruitment assumptions. The Panel agreed that this was sensible and the revised figures from a short report circulated by email (27/2/13) are presented below.

				percent below 0.2*SSB0		
steepness	SSB0	0.2*SSB0	SSBmsy	F35%=0.24	F40%=0.20	F that results in ~5% draws
0.6	139,200	27840	51300	26.1	7.2	0.19
0.7	128,100	25620	42960	9.7	2.0	0.22
0.8	119,200	23840	36940	4.1	0.7	0.24-0.25
emp.cdf	81,700	16340	28450 (F35) or 32400 (F40)	0.0	0.0	0.35-0.36

These results differed very slightly from those presented verbally at the meeting. There was some discussion regarding among the panel regarding 'central tendency' and the fact that averaging over the three scenarios (given the revised figures) gives a result that falls around the 5% risk criterion suggested by the SAW, but this still implies a five-fold increase in risk between $F_{40\%}$ and $F_{35\%}$, and the analysis of an additional steepness parameter confirms the non linear nature of this relationship and rapid increase in risk levels as steepness is reduced. However it should also be pointed out that the estimated risk levels under the 'averaged' stock recruitment results for the $F_{40\%}$ and $F_{35\%}$ reference point scenarios would be very low and low, respectively.

In my view the results presented do not support the SAW's case for changing the MSY proxy reference point from $F_{40\%}$ to $F_{35\%}$. Using central tendency for risk places it at the 5% margin proposed by the SAW. There is considerable uncertainty associated with the assessment (e.g. stock identity, catch data, ageing, biological parameters and a new model) and the sensitivity to these has not been extensively explored. The risk level could move above or below the threshold in response to any of these. Further, when the risk surface is looked at in the $F_{40\%}$-$F_{35\%}$ and steepness dimensions, it is apparent that the relative level of risk increases substantially between these F reference points and to significant levels at $F_{35\%}$ as steepness decreases, while risk levels at $F_{40\%}$ are far more robust to the decrease in steepness. The latter point concurs closely with Clark's (1993) findings and he also points out that correlation in recruitment variation (something that seems apparent in results from this assessment) increases the incidence of low spawning biomasses. It would seem sensible to explore the sensitivity of risk to the uncertainties associated with this assessment and/or to improve the understanding of its stock and recruitment dynamics before moving to a more risk prone reference point.

However, it should also be noted that the absolute level of risk associated with F40% (under all three plausible scenarios) is very low and that the reference point proposed by the SAW ($F_{35\%}$) has a risk level close to 10% under scenario iii (the worst of these three plausible cases).

It is also worth reiterating my view that the decision on acceptable risk levels should be made by managers and that in order to get a full picture of both the potential risks and benefits it would be useful to have figures for yield changes as well as risks in this analysis. From comments at the meeting my impression was that potential yield gains are not substantial.

The Panel therefore proposed $F_{40\%}$ be used as a proxy for F_{MSY}. This implies reference points of $F_{MSYproxy}$=0.2 and $SSB_{MSYproxy}$=32400t.

> ToR 6. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model developed for this peer review. In both cases, evaluate whether the stock is rebuilt.

The Review Panel agreed that the SAW met this ToR.

The previous stock assessment concluded that the stock was overfished and that overfishing was occurring. This assessment used a new model and revised data so direct comparison with previous reference points was not appropriate.

> a. If possible update the ASPM with new data and evaluate stock status (overfished and overfishing) with respect to the relevant BRP estimates.

The SAW updated the ASPM /SCAA model used in the previous assessment and reported details in appendix B1 to the SAW report noting that the 'RCp' assessment and a number of key sensitivities all suggest that the stock is not overfished and overfishing is not occurring. Tables Appendix B1.2 and B1.3 present results for a wide range of sensitivities supporting the above for most circumstances, with exceptions when M is assumed to be higher. However, it is not entirely clear from this table whether MSY rather than a proxy ($F_{40\%}$) have been taken as the overfishing criterion and the SAW appendix notes that estimates of current stock status are more optimistic when based on stock recruitment relationship based MSYs in comparison with the $F_{40\%}$ MSY proxy.

b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).

The SAW proposed $F_{35\%}$= 0.2 as an $F_{MSYproxy}$, with a corresponding $SSB_{MSYproxy}$ of 28,450t (SAW report p.27). The new ASAP assessment indicates that fully selected F_{2011} is 0.13 and SSB_{2011} is 26,877t. Adopting these reference points would indicate that the stock is not overfished (SSB_{2011}>$SSB_{MSYproxy}/2$) and not subject to overfishing (F_{2011}<$F_{MSYproxy}$).

The Panel did not accept the SAW case for changing to $F_{35\%}$ as the F_{MSY} proxy, recommending $F_{40\%}$ (see ToR 5). This implies an $F_{MSYproxy}$ of 0.2 and an $SSB_{MSYproxy}$ of 32400t. Under this reference point definition the stock is not overfished and overfishing is not occurring.

ToR 7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., the probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).

a. Provide numerical annual projections (3-5 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).

b. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.

The SAW addressed this ToR only to a limited extent.

The SAW report provided a short paragraph outlining deterministic results of short term projections with numbers derived from the base case MCMC runs. Scenarios were run at the OFL ($F_{MSYproxy}$ proposed by the SAW) and at 0.75 of this fishing level to estimate TACs. No tables or figures of projection output and probability distributions of the metrics specified in the ToR were provided in the report.

During the meeting, further projections were brought forward and presented. As suggested by the Panel, these generated recruitment values from a recent time period (1995-2009) rather than the whole time series, as recruitment has been consistently below average over most of the last two decades. This projection is considered more likely since there is evidence of serial auto-correlation in estimated recruitment, which was near average levels through the first 29 years of the time series, high in the middle 10 years (the 6 highest estimates all occur in this period) and has been below average over the most recent 20 years. Although there is some evidence for increased recruitment in the most recent years, some caution is required with respect to these figures, because retrospective over-estimation bias occurs from recruitment in this model. These new projections provided confidence intervals for SSB at $F_{35\%}$ (the $F_{MSYproxy}$ proposed by the

SAW) and at 0.75 of this level, as up to this point the SARC had not identified any problem with this reference point. For the same reason, no runs were presented using an $F_{MSYproxy}$ of $F_{40\%}$ = 0.2, as subsequently proposed by the Review Panel.

The SAW did not provide any outputs detailing the probability of falling below thresholds and did not consider alternative states of nature, other than the recent recruitment scenario mentioned above.

Production of projections using an $F_{MSYproxy}$ of $F_{40\%}$ and more complete presentation of probability distributions relating to their outputs remains a task to be completed after the SARC meeting.

c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

The SAW did not explicitly address this part of the ToR.

The Review Panel noted that current F is well below potential $F_{MSYproxies}$ also below the assumed natural mortality level. Therefore the stock is likely to have a low likelihood of being overfished or of experiencing overfishing in the short term.

The SAW report did not provide supporting information on white hake natural mortality, but did note that the very high catch levels sustained over decades around 1900 did suggest that productivity may have been higher in the past. It also noted anecdotal reports that white hake were being seen in recent years in areas where they had not been seen previously for many years. Although possibly suggestive of increasing abundance and productivity of white hake in this area, some caution is required as the 'stock' being assesses is part of a larger stock complex with migratory behaviour (see ToR 8) and circumstances in other parts of its distribution could affect its susceptibility to exploitation.

White hake is taken primarily as a by-catch in fisheries targetting mixed groundfish. It could therefore be susceptible to overexploitation if fishing effort for these species increases, but conversely may receive protection from measures brought in to control fishing for other more targetted species. Its susceptibility to overfishing therefore needs to be considered in a multispecies and mixed fishery context.

Background documentation provided to the SARC included literature relating to the historical distribution of white hake, which suggested that its abundance had declined in areas where the inshore forage species alewife had also declined and postulated that seasonal migration patterns for the highly predatory white hake were influenced by the seasonal distribution of forage species. Perceived abundance of white hake could therefore vary due to changes in its abundance rather than the overall abundance of the stock. Further, both stock productivity and susceptibility to fishing in inshore areas could be influenced by the abundance of suitable forage species.

ToR 8. Evaluate the validity of the current **stock** definition, taking into account what is known about migration among stock areas. Make a recommendation about whether there is a need to modify the current stock definition for future stock assessments.

The SAW addressed this ToR and there was some discussion regarding stock structure during the SARC meeting. The SAW commented in its executive summary that the current definition is appropriate given a slight modification needed to account for different spatial coverage of the new survey vessel.

The SAW presented information on the spatial distributions of white hake, its spawning locations and larval distributions. It noted that no genetic studies were available for the relevant US waters, but that studies in Canadian waters suggested the existence of several stocks in the NW Atlantic that overlapped in distribution and mixed, but also showed a high degree of genetic integrity and distinct spawning locations. The hake population in the Gulf of Maine and Georges Bank was considered likely to be part of a larger Scotian Shelf stock. The 'stock' defined for this assessment was considered likely to have at least two reproductive components.

The Review Panel agreed that the stock definition provides a pragmatic basis for stock assessment. The Panel also noted that the assessment did not explore alternative assumptions of stock structure in its modelling evaluations. Further, no information was presented regarding white hake fishery and population trends for neighbouring areas that might in reality be part of the same stock. Further research into stock structure and migration patterns of the white hake that frequent US waters would provide a better basis for stock definition.

> ToR 9. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in the most recent SARC reviewed assessment and review panel reports. Identify new research recommendations.

The SAW completed this ToR.

The SAW compiled a list of 13 research recommendations from previous assessment groups. Most had been completed or were no longer considered relevant. The SAW suggested a further eight recommendations for future work, including some that were carried forward.

The new recommendations are considered under the following topic headings:

General assessment methodology development and testing

i) Further comparison of the SCAA and ASAP models. Perhaps institute a comparison using a simulated population and a common model configuration.
ii) Review of general SARC working group procedures which could for example include how new models are evaluated, the ability to modify models in real time, and policies for model testing prior to meetings using simulated data.

The Review Panel thought that these were valuable topics for research not specific to white hake that could be considered through generic groups working on methodological development and that utilising standard simulated datasets could facilitate evaluation of model utility.

Development of monitoring schemes and methodology specific to white hake

iii) Complete ageing of samples collected by the Observer program, the shrimp survey and state surveys (ME/NH survey).
iv) Continue production ageing of NEFSC Survey samples.
v) Conduct sensitivity testing of the ASAP model using the shrimp and ME/NH survey indices.
vi) Further explore swept area biomass estimation for white hake.

These topics were largely related to routine monitoring and processing of data relating specifically to the white hake assessment. The Panel supported items iii-v, but felt that swept area biomass estimation did not offer significant benefits and was likely to be both difficult and expensive.

<u>Development of monitoring systems in general</u>

vii) Develop improved calibration methods to adjust total fish length for fish with heads removed.
viii) Consider conducting cooperative research to collect intact fish from commercial gear.

The Panel thought that item vii would be difficult and that extrapolating total length from a relatively short metric such as head length could introduce additional uncertainty. However, the Panel did appreciate that collection of heads would provide otoliths for ageing. Further, basing measurement on hard parts of the head such as for example maxilla (jaw) length, or snout to orbit or gill cover length could reduce variability due to muscular tension and/or flexing and might to some extent compensate for the use of a smaller dimension. The Panel considered that developing a cooperative programme with Industry (item viii) to coherently sample length and age may be beneficial, although there may be issues relating to quality control and the use of observers can be expensive.

Additional research topics such as investigations into the stock structure and migration patterns of white hake and investigating the rate of natural mortality for white hake could be considered under a more biological studies remit.

4. Acknowledgements

I sincerely thank all the technical working group members for their substantial efforts in preparing the reports, informative presentations of the SAW results and provision of helpful responses and additional information to answer the SARC’s questions. Staff at the Woods Hole Laboratory and other meeting participants were hospitable throughout which made the meeting enjoyable as well as stimulating and challenging. Special thanks are due to Jim Weinberg and Paul Rago for their guidance on the process, while the industrious background efforts of Anne O’Brien ensured meeting logistics ran smoothly. Thanks are also due to the other members of SARC for productive discussions on the assessments and particularly to Ed Houde (Chair) for ensuring progress and focus throughout the meeting.

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Appendix 2: CIE Statement of Work

Statement of Work

56th Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC): Benchmark stock assessments for Atlantic surfclam and White hake
Statement of Work (SOW) for CIE Panelists (including a description of SARC Chairman's duties)

BACKGROUND
The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Representative (COR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are independently selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

SCOPE
Project Description: The Northeast Regional Stock Assessment Review Committee (SARC) meeting is a formal, multiple-day meeting of stock assessment experts who serve as a panel to peer-review tabled stock assessments and models. The SARC is the cornerstone of the Northeast Stock Assessment Workshop (SAW) process, which includes assessment development (SAW Working Groups or ASMFC technical committees), assessment peer review, public presentations, and document publication. This review determines whether the scientific assessments are adequate to serve as a basis for developing fishery management advice. Results provide the scientific basis for fishery management in the northeast region.

The purpose of this panel review meeting will be to provide an external peer review of stock assessments for Atlantic surfclam (*Spisula solidissima*) and white hake (*Urophycis tenuis*). Atlantic surfclam is a marine bivalve found along the US east coast. White hake is a demersal gadoid species found from Newfoundland to Southern New England, and common on muddy bottom throughout the Gulf of Maine. The last peer reviewed benchmark assessment of Atlantic surfclam was in 2009 as part of SARC 49. The last peer reviewed assessment of white hake took place in GARM III in 2008, followed by a more recent data update in early 2012.

OBJECTIVES

The SARC review panel will be composed of three appointed reviewers from the Center of Independent Experts (CIE), and an independent chair from the SSC of the New England or MidAtlantic Fishery Management Council. The SARC panel will write the SARC Summary Report and each CIE reviewer will write an individual independent review report.

Duties of reviewers are explained below in the "**Requirements for CIE Reviewers**", in the "**Charge to the SARC Panel**" and in the "**Statement of Tasks**". The stock assessment Terms of Reference (ToRs) are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**. The SARC Summary Report format is described in **Annex 4.**

Requirements for the reviewers: Three reviewers shall conduct an impartial and independent peer review of the Atlantic surfclam and white hake stock assessments, and this review should be in accordance with this SoW and stock assessment ToRs herein. The reviewers shall have working knowledge and recent experience in the application of modern fishery stock assessment models. Expertise should include statistical catch-at-age, state-space and index methods. Reviewers should also have experience in evaluating measures of model fit, identification, uncertainty, and forecasting. Reviewers should have experience in development of Biological Reference Points that includes an appreciation for the varying quality and quantity of data available to support estimation of Biological Reference Points. For surfclams, familiarity with dynamics of sessile species and spatial management is desirable. For white hake, familiarity with gadid fish stocks would be desirable.

PERIOD OF PERFORMANCE

The period of performance begins on the award date, and the contractor shall complete the tasks and deliverables as specified in this statement of work. Each reviewer's duties shall not exceed a maximum of 16 days to complete all work tasks of the peer review described herein.

Not covered by the CIE, the SARC chair's duties should not exceed a maximum of 16 days (i.e., several days prior to the meeting for document review; the SARC meeting in Woods Hole; several days following the open meeting for SARC Summary Report preparation).

PLACE OF PERFORMANCE AND TRAVEL

Each reviewer shall conduct an independent peer review during the panel review meeting scheduled in Woods Hole, Massachusetts during February 19-22, 2013.

STATEMENT OF TASKS

Charge to SARC panel: During the SARC meeting, the panel is to determine and write downwhether each stock assessment Term of Reference (ToR) of the SAW (see **Annex**

2) was or was not completed successfully. To make this determination, panelists should consider whether the work provides a scientifically credible basis for developing fishery management advice. Criteria to consider include: whether the data were adequate and used properly, the analyses and models were carried out correctly, and the conclusions are correct/reasonable. **If alternative assessment models and model assumptions are presented, evaluate their strengths and weaknesses and then recommend which, if any, scientific approach should be adopted.** Where possible, the SARC chair shall identify or facilitate agreement among the reviewers for each stock assessment Term of Reference of the SAW.

If the panel rejects any of the current BRP or BRP proxies (for B_{MSY} and F_{MSY} and MSY), the panel should explain why those particular BRPs or proxies are not suitable, and the panel should recommend suitable alternatives. If such alternatives cannot be identified, then the panel should indicate that the existing BRPs or BRP proxies are the best available at this time.

Each reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Tasks prior to the meeting: The contractor shall independently select qualified reviewers that do not have conflicts of interest to conduct an independent scientific peer review in accordance with the tasks and ToRs within the SoW. Upon completion of the independent reviewer selection by the contractor's technical team, the contractor shall provide the reviewer information (full name, title, affiliation, country, address, email, and FAX number) to the COR, who will forward this information to the NMFS Project Contact no later than the date specified in the Schedule of Milestones and Deliverables. The contractor shall be responsible for providing the SoW and stock assessment ToRs to each reviewer. The NMFS Project Contact will be responsible for providing the reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact will also be responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COR prior to the commencement of the peer review.

<u>Foreign National Security Clearance</u>: The reviewers shall participate during a panel review meeting at a government facility, and the NMFS Project Contact will be responsible for obtaining the Foreign National Security Clearance approval for the reviewers who are non-US citizens. For this reason, the reviewers shall provide by FAX (not by email) the requested information (e.g., first and last name, contact information, gender, birth date, country of birth, country of citizenship, country of permanent residence, whether there is dual citizenship, passport number, country of passport) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/.

Pre-review Background Documents and Working Papers: Approximately two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the SARC chair and CIE reviewers the necessary background information and reports (i.e., working papers) for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the COR on where to send documents. The reviewers are responsible only for the pre-review documents that are delivered to the contractor in accordance to the SoW scheduled deadlines specified herein. The reviewers shall read all documents deemed as necessary in preparation for the peer review.

Tasks during the panel review meeting: Each reviewer shall conduct the independent peer review in accordance with the SoW and stock assessment ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs shall not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COR and contractor.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the stock assessment ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

(SARC chair)
Act as chairperson, where duties include control of the meeting, coordination of presentations and discussions, making sure all stock assessment Terms of Reference of the SAW are reviewed, control of document flow, and facilitation of discussion. For each assessment, review both the Assessment Report and the draft Assessment Summary Report. The draft Assessment Summary Report is reviewed to assure that it is consistent with the outcome of the peer review, particularly statements that address stock status and assessment uncertainty.

During the question and answer periods, provide appropriate feedback to the assessment scientists on the sufficiency of their analyses. It is permissible to discuss the stock assessment and to request additional information if it is needed to clarify or correct an existing analysis and if the information can be produced rather quickly.

(SARC CIE reviewers)
For each stock assessment, participate as a peer reviewer in panel discussions on assessment validity, results, recommendations, and conclusions. If alternative assessment models and model assumptions are presented, evaluate their strengths and weaknesses and then recommend which, if any, scientific approach should be adopted. From a reviewer's point of view, determine whether each stock assessment Term of Reference of the SAW was completed successfully. Terms of Reference that are completed successfully are likely to serve as a basis for providing scientific advice to management.

If a reviewer considers any existing Biological Reference Point or BRP proxy to be inappropriate, the reviewer should try to recommend an alternative, should one exist. Review both the Assessment Report and the draft Assessment Summary Report. The draft Assessment Summary Report is reviewed to assure that it is consistent with the outcome of the peer review, particularly statements that address stock status and assessment uncertainty.

During the question and answer periods, provide appropriate feedback to the assessment scientists on the sufficiency of their analyses. It is permissible to request additional information if it is needed to clarify or correct an existing analysis and if the information can be produced rather quickly.

Tasks after the panel review meeting:

SARC CIE reviewers:
Each CIE reviewer shall prepare an Independent CIE Report (see **Annex 1**). This report should explain whether each stock assessment Term of Reference of the SAW was or was not completed successfully during the SARC meeting, using the criteria specified above in the "Charge to SARC panel" statement. If alternative assessment models and model assumptions were presented, evaluate their strengths and weaknesses and then recommend which, if any, scientific approach should be adopted.

If any existing Biological Reference Points (BRP) or their proxies are considered inappropriate, the Independent CIE Report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing BRPs are the best available at this time.

During the meeting, additional questions that were not in the Terms of Reference but that are directly related to the assessments may be raised. Comments on these questions should be included in a separate section at the end of the Independent CIE Report produced by each reviewer.

The Independent CIE Report can also be used to provide greater detail than the SARC Summary Report on specific stock assessment Terms of Reference or on additional questions raised during the meeting.

SARC chair:
The SARC chair shall prepare a document summarizing the background of the work to be conducted as part of the SARC process and summarizing whether the process was adequate to complete the stock assessment Terms of Reference of the SAW. If appropriate, the chair will include suggestions on how to improve the process. This document will constitute the introduction to the SARC Summary Report (see **Annex 4**).

SARC chair and CIE reviewers:
The SARC Chair, with the assistance from the CIE reviewers, will prepare the SARC Summary Report. Each CIE reviewer and the chair will discuss whether they hold similar

views on each stock assessment Term of Reference and whether their opinions can be summarized into a single conclusion for all or only for some of the Terms of Reference of the SAW. For terms where a similar view can be reached, the SARC Summary Report will contain a summary of such opinions. In cases where multiple and/or differing views exist on a given Term of Reference, the SARC Summary Report will note that there is no agreement and will specify - in a summary manner – what the different opinions are and the reason(s) for the difference in opinions.

The chair's objective during this SARC Summary Report development process will be to identify or facilitate the finding of an agreement rather than forcing the panel to reach an agreement. The chair will take the lead in editing and completing this report. The chair may express the chair's opinion on each Term of Reference of the SAW, either as part of the group opinion, or as a separate minority opinion.

The SARC Summary Report (please see **Annex 4** for information on contents) should address whether each stock assessment Term of Reference of the SAW was completed successfully. For each Term of Reference, this report should state why that Term of Reference was or was not completed successfully. The Report should also include recommendations that might improve future assessments.

If any existing Biological Reference Points (BRP) or BRP proxies are considered inappropriate, the SARC Summary Report should include recommendations and justification for suitable alternatives. If such alternatives cannot be identified, then the report should indicate that the existing BRP proxies are the best available at this time.

The contents of the draft SARC Summary Report will be approved by the CIE reviewers by the end of the SARC Summary Report development process. The SARC chair will complete all final editorial and formatting changes prior to approval of the contents of the draft SARC Summary Report by the CIE reviewers. The SARC chair will then submit the approved SARC Summary Report to the NEFSC contact (i.e., SAW Chairman).

DELIVERY

Each reviewer shall complete an independent peer review report in accordance with the SoW.

Each reviewer shall complete the independent peer review according to required format and content as described in **Annex 1**. Each reviewer shall complete the independent peer review addressing each stock assessment ToR listed in **Annex 2**.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.
1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.

2) Participate during the panel review meeting at the Woods Hole, Massachusetts during February 19-22, 2013.
3) Conduct an independent peer review in accordance with this SoW and the assessment ToRs (listed in **Annex 2**).
4) No later than March 8, 2013, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to Dr. David Die ddie@rsmas.miami.edu. Each CIE report shall be written using the format and content requirements specified in **Annex 1**, and address each assessment ToR in **Annex 2**.

Schedule of Milestones and Deliverables: The contractor shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.
January 15, 2013 Contractor sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
February 5, 2013 NMFS Project Contact will attempt to provide reviewers the prereview documents
February 19-22, 2013 Each reviewer participates and conducts an independent peer review during the panel review meeting in Woods Hole, MA
February 22, 2013 SARC Chair and CIE reviewers work at drafting reports during meeting at Woods Hole, MA, USA
March 8, 2013 Reviewers submit draft independent peer review reports to the contractor's technical team for independent review
March 8, 2013 Draft of SARC Summary Report, reviewed by all CIE reviewers, due to the SARC Chair *
March 15, 2013 SARC Chair sends Final SARC Summary Report, approved by CIE reviewers, to NEFSC contact (i.e., SAW Chairman)
March 22, 2013 Contractor submits independent peer review reports to the COR who reviews for compliance with the contract requirements
March 29, 2013 The COR distributes the final reports to the NMFS Project Contact and regional Center Director
* The SARC Summary Report will not be submitted, reviewed, or approved by the CIE.
The SAW Chairman will assist the SARC chair prior to, during, and after the meeting in ensuring that documents are distributed in a timely fashion.
NEFSC staff and the SAW Chairman will make the final SARC Summary Report available to the public. Staff and the SAW Chairman will also be responsible for production and publication of the collective Working Group papers, which will serve as a SAW Assessment Report.

Modifications to the Statement of Work: Requests to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent substitutions.
The Contracting Officer will notify the COR within 10 working days after receipt of all required information of the decision on substitutions. The COR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the reviewers to complete the deliverable in accordance with the SoW is not adversely impacted.

The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: The deliverables shall be the final peer review report from each reviewer that satisfies the requirements and terms of reference of this SoW. The contract shall be successfully completed upon the acceptance of the contract deliverables by the COR based on three performance standards:
(1) each report shall be completed with the format and content in accordance with **Annex 1**,
(2) each report shall address each stock assessment ToR listed in **Annex 2**,
(3) each report shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Upon the acceptance of each independent peer review report by the COR, the reports will be distributed to the NMFS Project Contact and pertinent NMFS science director, at which time the reports will be made publicly available through the government's website. The contractor shall send the final reports in PDF format to the COR, designated to be William Michaels, via email William.Michaels@noaa.gov

Support Personnel:

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Annex 1: Format and Contents of Independent Peer Review Report

1.The independent peer review report shall be prefaced with an Executive Summary providing a concise summary of whether they accept or reject the work that they reviewed, with an explanation of their decision (strengths, weaknesses of the analyses, etc.).

2.The main body of the report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Findings of whether they accept or reject the work that they reviewed, and an explanation of their decisions (strengths, weaknesses of the analyses, etc.) for each ToR, and Conclusions and Recommendations in accordance with the ToRs. For each assessment reviewed, the report should address whether each ToR of the SAW was completed successfully. For each ToR, the Independent Review Report should state why that ToR was or was not completed successfully. To make this determination, the SARC chair and reviewers should consider whether the work provides a scientifically credible basis for developing fishery management advice.

a.Reviewers should describe in their own words the review activities completed during the panel review meeting, including a concise summary of whether they accept or reject the work that they reviewed, and explain their decisions (strengths, weaknesses of the analyses, etc.), conclusions, and recommendations.

b.Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

c.Reviewers should elaborate on any points raised in the SARC Summary Report that they feel might require further clarification.

d.Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

e.The independent report shall be a stand-alone document for others to understand the proceedings and findings of the meeting, regardless of whether or not others read the SARC Summary Report. The independent report shall be an independent peer review of each ToR, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

Appendix 1: Bibliography of materials provided for review
Appendix 2: A copy of this Statement of Work
Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: 56th SAW/SARC Stock Assessment Terms of Reference

A. Atlantic surfclam

1. Estimate catch from all sources including landings and discards. Describe the spatial and temporal patterns in landings, discards, fishing effort and LPUE. Characterize the uncertainty in these sources of data.

2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, relevant cooperative research, etc.). Investigate the utility of commercial LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data.

3. Evaluate the current **stock** definition in terms of spatial patterns in biological characteristics, population dynamics, fishery patterns, the new cooperative survey, utility of biological reference points, etc. If appropriate, recommend one or more alternative stock definitions, based on technical grounds. Integrate these results into TOR-4.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-3), and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results. Review the performance of historical projections with respect to stock size, recruitment, catch and fishing mortality.

5. State the existing **stock status** definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. This should be carried out using the existing stock definition and, if possible, for the recommended "alternative" stock definitions from TOR-3. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the appropriateness of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

6. Evaluate stock status with respect to the existing assessment model and with respect to any new assessment model. Determine stock status based on the existing stock definition and, if appropriate and if time permits, for "alternative" stock definitions from TOR-3.

    a. When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.

    b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).

7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).

    a. Provide numerical annual projections (3-5 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).

    b. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.

    c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

8. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in the most recent SARC reviewed assessment and review panel reports. Identify new research recommendations.

B. White hake

1. Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of fishing effort. Characterize the uncertainty in these sources of data. Analyze and correct for any species mis-identification in these data. Comment on the consistency of the approach to identify the catch of white hake with respect to that used in the red hake assessment.

2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Investigate the utility of commercial or recreational LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data.

3. Evaluate the utility of pooled age-length keys for development of a stock assessment model.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results. Review the performance of historical projections with respect to stock size, recruitment, catch and fishing mortality.

5. State the existing **stock status** definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

6. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model developed for this peer review. In both cases, evaluate whether the stock is rebuilt.

   a. If possible update the ASPM with new data and evaluate stock status (overfished and overfishing) with respect to the relevant BRP estimates.
   b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).

7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., the probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).

   a. Provide numerical annual projections (3-5 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).
   b. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.
   c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

8. Evaluate the validity of the current **stock** definition, taking into account what is known about migration among stock areas. Make a recommendation about whether there is a need to modify the current stock definition for future stock assessments.
9. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in the most recent SARC reviewed assessment and review panel reports. Identify new research recommendations.

Annex 2 (cont.):

Appendix to the Assessment TORs:

Explanation of "Acceptable Biological Catch" (DOC Natl. Standard Guidelines, Fed. Reg., vol. 74, no. 11, 1/16/2009):

> *Acceptable biological catch (ABC)* is a level of a stock or stock complex's annual catch that accounts for the scientific uncertainty in the estimate of [overfishing limit] OFL and any other scientific uncertainty…" *(p. 3208) [In other words, OFL ≥ ABC.]*
>
> *ABC for overfished stocks.* For overfished stocks and stock complexes, a rebuilding ABC must be set to reflect the annual catch that is consistent with the schedule of fishing mortality rates in the rebuilding plan. *(p. 3209)*
>
> NMFS expects that in most cases ABC will be reduced from OFL to reduce the probability that overfishing might occur in a year. (p. 3180)
>
> ABC refers to a level of ''catch'' that is ''acceptable'' given the ''biological'' characteristics of the stock or stock complex. As such, [optimal yield] OY does not equate with ABC. The specification of OY is required to consider a variety of factors, including social and economic factors, and the protection of marine ecosystems, which are not part of the ABC concept. (p. 3189)

Explanation of "Vulnerability" (DOC Natl. Standard Guidelines, Fed. Reg., vol. 74, no. 11, 1/16/2009):

> *"Vulnerability.* A stock's vulnerability is a combination of its productivity, which depends upon its life history characteristics, and its susceptibility to the fishery. Productivity refers to the capacity of the stock to produce MSY and to recover if the population is depleted, and susceptibility is the potential for the stock to be impacted by the fishery, which includes direct captures, as well as indirect impacts to the fishery (e.g., loss of habitat quality)." (p. 3205)

Rules of Engagement among members of a SAW Assessment Working Group:

> Anyone participating in SAW assessment working group meetings that will be running or presenting results from an assessment model is expected to supply the source code, a compiled executable, an input file with the proposed configuration, and a detailed model description in advance of the model meeting. Source code for NOAA Toolbox programs is available on request. These measures allow transparency and a fair evaluation of differences that emerge between models.

Annex 3: DRAFT Meeting Agenda

[Note: The final SARC 56 agenda is still in preparation. The meeting will start at 10am on Feb. 19 and end late in the day on Friday, Feb. 22, 2013. Reviewers must attend the entire meeting. A draft agenda follows:]

56th Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC): Benchmark stock assessments for Atlantic surfclam and white hake

Feb. 19-22, 2013

Stephen H. Clark Conference Room – Northeast Fisheries Science Center
Woods Hole, Massachusetts

DRAFT AGENDA* (version: 7 Jan. 2013)

TOPIC	PRESENTER(S)	SARC LEADER	RAPPORTEUR
Tuesday, Feb. 19			
10 – 10:30 AM			
Welcome	**James Weinberg**, SAW Chair		
Introduction		**Edward Houde**, SARC Chair	
Agenda			
Conduct of Meeting			
10:30 – 3:15	Assessment Presentation (A. Atlantic Surfclam)		
	TBD	TBD	TBD
3:15 –	SARC Discussion w/ Presenters (A. Atlantic Surfclam)		
		Edward Houde, SARC Chair	TBD
Wednesday, Feb. 20			
9 –	Assessment Presentation (B. White Hake)		
	TBD	TBD	TBD
1:30 –	SARC Discussion w/presenters (B. White Hake)		
	Edward Houde,	SARC Chair	TBD
4	Revisit with presenters (A. Atlantic Surfclam)		
	Edward Houde,	SARC Chair	TBD
6:45 PM	**(**Social Gathering –**)**		
Thursday, Feb. 21			
8:30 –	Revisit with presenter (B. White hake)		
		Edward Houde, SARC Chair	TBD
10:30 Review/edit	Assessment Summary Report (B. White Hake)		
		Edward Houde, SARC Chair	TBD
3:00 Review/edit	Assessment Summary Report (A. Surfclam)		

Edward Houde, SARC Chair TBD

Friday, Feb. 22

9:00 AM – 5:00 PM SARC Report writing. (closed meeting)

*All times are approximate, and may be changed at the discretion of the SARC chair. The meeting is open to the public, except where noted.

Annex 4: Contents of SARC Summary Report

1.The main body of the report shall consist of an introduction prepared by the SARC chair that will include the background, a review of activities and comments on the appropriateness of the process in reaching the goals of the SARC. Following the introduction, for each assessment reviewed, the report should address whether each Term of Reference of the SAW Working Group was completed successfully. For each Term of Reference, the SARC Summary Report should state why that Term of Reference was or was not completed successfully.

To make this determination, the SARC chair and CIE reviewers should consider whether the work provides a scientifically credible basis for developing fishery management advice. Scientific criteria to consider include: whether the data were adequate and used properly, the analyses and models were carried out correctly, and the conclusions are correct/reasonable. If the CIE reviewers and SARC chair do not reach an agreement on a Term of Reference, the report should explain why. It is permissible to express majority as well as minority opinions.

The report may include recommendations on how to improve future assessments.

2. If any existing Biological Reference Points (BRP) or BRP proxies are considered inappropriate, include recommendations and justification for alternatives. If such alternatives cannot be identified, then indicate that the existing BRPs or BRP proxies are the best available at this time.

3. The report shall also include the bibliography of all materials provided during the SAW, and relevant papers cited in the SARC Summary Report, along with a copy of the CIE Statement of Work.

The report shall also include as a separate appendix the assessment Terms of Reference used for the SAW, including any changes to the Terms of Reference or specific topics/issues directly related to the assessments and requiring Panel advice.

Appendix 3: SARC Review Panel Membership

Prof. E. Houde, University of Maryland, US. Chair.
Dr. M. Cryer, MPI, NZ. CIE reviewer.
Mr. M. Smith, Cefas, UK. CIE reviewer.
Dr. K. Stokes, NZ. CIE reviewer.

The full participant list for the meeting is provided below.

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